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Engine Electronics Overview

Subject **Page**

Initial Print Date: 03/11 Revision Date:

Engine Electronics Overview

Model: All

Production: All

OBJECTIVES

After completion of this module you will be able to:

- Understand the basics of Engine Electronics
- Describe the Power Supply for the Fuel Injectors and Ignition Coils
- Understand the EDK and Idle Air Actuator Operation
- Explain Why Two Sensors are Used to Monitor Accelerator Pedal Movement
- List the Inputs Required for Fuel Injector Operation
- Name the Two Types of Emissions the ECM Controls
- Understand DM-TL Evaporative Leak Testing

Introduction

Welcome to ST055 Engine Electronics!

ST055 Engine Electronics is 5 days in length.

This handout is representative of selected 6, 8, and 12 cylinder Engine Management Systems.The handout serves two purposes, “stand alone” system reference material for the BMW Technician and a platform for Instructor selected topics.

Understanding that all of the material pertaining Engine Management can’t be covered in five days, this class will be system based. This approach will ensure that the student comprehends how BMW Engine Management Systems work and thus is able to diagnose them. Nevertheless, BMW Technicians can find detailed information from particular Engine Management Systems in former BMW Training Manuals.

Objectives

Familiarize BMW Technicians with an understanding of the current Engine Electronics Systems and transferable diagnostic skills. Perform hands on practicals in the shop to ensure “all” Technicians have participated in diagnosis and component testing.

Objectives are provided on page 2 of each system to guide you to the key learning points of each module. A final test will be given at the end of the course.

It is very important to study the content which will assist you with important “on the job” information and successful completion of this course.

As a Mention the following information can be found online...

- Service Information
  Bulletins
- Technical Training Information
  Courses
- Repair Information
  Manuals
- Technician Feedback Systems
  Quality Control Information Reports

The chart shown below is a quick reference of BMW Engine Management Systems by application to BMW models, engines and model years. This will help you to get familiar with the systems by identifying the correct version that you are diagnosing.

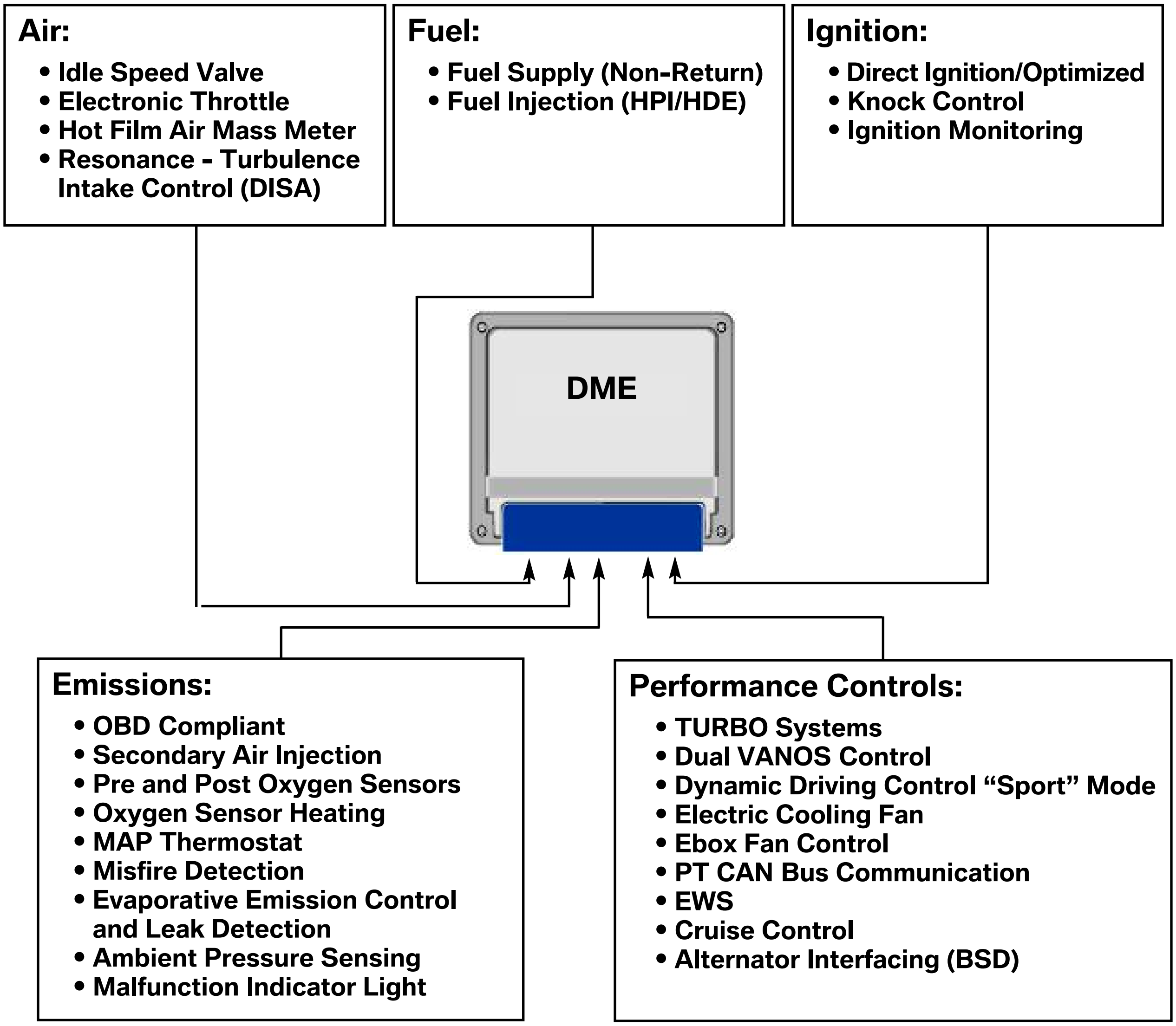
ENGINE MANAGEMENT CONTROL VERSIONS			
VERSION	**VEHICLE MODEL**	**ENGINE**	**MODEL YEAR**
M1.2	E32 / M5	M70 / S38	M70 = 1988 - 1999 S38 = 1991 - 1993
M1.7	E31 / E32	M70	1991 - 1994
M1.7	E30	M42	1990 - 1993
M1.7	E36	M42	1992 - 1995
M1.7	E36	M42 / DISA	1995
M1.7.1	E31	S70	1991 - 1992
M1.7.2	E36	M42 /DISA	1992
M3.1	E34	M50	1991 - 1992
M3.1	E36	M50	1992
M3.3	E32	M60	1993 - 1994
M3.3	E31 / E34	M60	1994 - 1995
M3.3.1	E34 / E36	M50TU	1993 - 1995
M5.2	E36 / Z3	M44	1996 - 1998
M5.2	E31 / E38 / E39	M62 / M73	1995 - 1997
MS41.1	E36 / E39 /Z3	M52	1996 - 1998
MS41.2	E36 M3	S52	1996 - 1998
M5.2.1	E38 / E39	M62 / M73	1998 - 1999
MS42	E46 / E39 /Z3	M52TU	1998 - 2000
MS43	E46 / E39 / E53 / Z3	M54	E46 2001 - 2002 Z3 2001 - 2002 E39 2001 - 2003 E53 2001 - 2006
ME7.2	E39 / E38 / E53	M62TU	1999 - 2001
MS S52	E39 M5 / E52 Z8	S62	M5 1999 - 2003 Z8 2000 - 2003
MS S54	E46 M3	S54	2001 -2007
			BOSH = M; SIEMENS = MS

ENGINE MANAGEMENT CONTROL VERSIONS

VERSION	VEHICLE MODEL	ENGINE	MODEL YEAR
MS45	E85	M54	2003 - 2006
MS45	E83 all except M54B30 AUTO	M54	2003 - 2006
MS54.1	E83 with M54B30 auto	M54	2003 - 2006
MS45.1	E46	M54	2003 - 2006
MS45.1	E46	M56 SULEV	2003 - 2006
ME 9.2	E65/66	N62	2002 - 2003
ME9.2.1	E53 / E60 / E63 / E64 / E65 / E66	N62	2004 - 2004
ME 9.2.2	E53 / E60 / E63 / E64 / E65 / E66	N62	2005 - 2007
MED 9.2.1	E66	N73	2003 - 2006
ME 9.2.3	E70	N62	2006 - 2010
MSS65	M5, M6 (E6x)	S85	2006 - 2009
MSV70	E90, E91, E92, E93, E60, E70.	N52	2004 - 2006
MSV80	E82, E88, E90, E91, E92, E93, E60, E70.	N52KP	2006 -
MSD80	E82, E90, E92, E93, E60, E61.	N54	2006 - 2008
MSD81	E70, E71, E82, E84, E88, E89, E90, E92, E93, F07, F10	N54	2008 -
MEVD 17.2	E82, E88, E90, E91, E92, E93, E60, E70.	N55	2010 -
MSD85	E70, E71, E72, F01, F02, F04, F07, F10	N63	2009 -
MSD85.1	E70 M / E71 M	S63	2009 -
MSD87-12	F01, F02	N74	2009 -

BOSH = M; SIEMENS = MS

Engine Electronics Overview



Air:

- Idle Speed Valve
- Electronic Throttle
- Hot Film Air Mass Meter
- Resonance - Turbulence Intake Control (DISA)

Fuel:

- Fuel Supply (Non-Return)
- Fuel Injection (HPI/HDE)

Ignition:

- Direct Ignition/Optimized
- Knock Control
- Ignition Monitoring

Emissions:

- OBD Compliant
- Secondary Air Injection
- Pre and Post Oxygen Sensors
- Oxygen Sensor Heating
- MAP Thermostat
- Misfire Detection
- Evaporative Emission Control and Leak Detection
- Ambient Pressure Sensing
- Malfunction Indicator Light

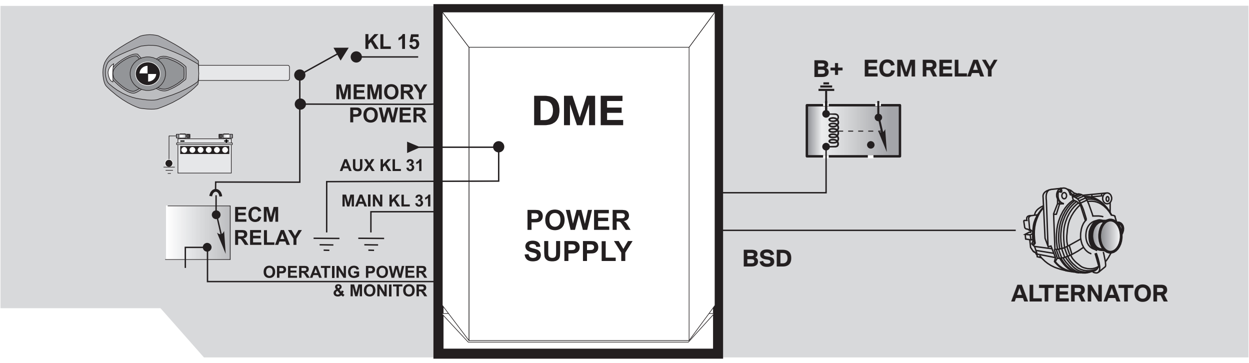
Performance Controls:

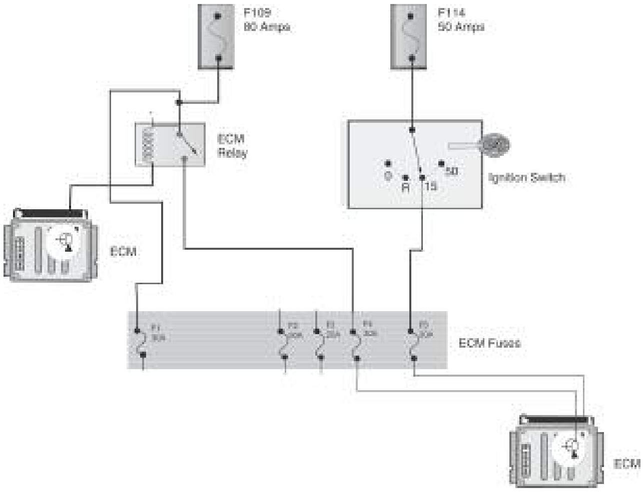
- TURBO Systems
- Dual VANOS Control
- Dynamic Driving Control “Sport” Mode
- Electric Cooling Fan
- Ebox Fan Control
- PT CAN Bus Communication
- EWS
- Cruise Control
- Alternator Interfacing (BSD)

NOTES
PAGE

Power Supply Overview

Example of IPO for a Power Supply System





One of the main purposes of the ECM is to control de Power Supply of several components. In the following pages you will find a generic explanation on how this system works. For more detailed information please access BMW Training Reference Manuals found online.

KL_30 - Battery Voltage: B+ is the main supply of operating voltage to the ECM.

The power supplies (KL_15 and ECM Relay) are fused to the ECM. The fuses are housed in the Engine Fuse Block located in the Electronics Box.

KL_15 - Ignition Switch. When the ignition is switched “ON” the ECM is informed that the engine is about to be started. KL_15 (fused) supplies voltage to the Engine Control Module Relay and the Fuel Injector Relay. Switching KL_15 “OFF” removes the ECM operating voltage.

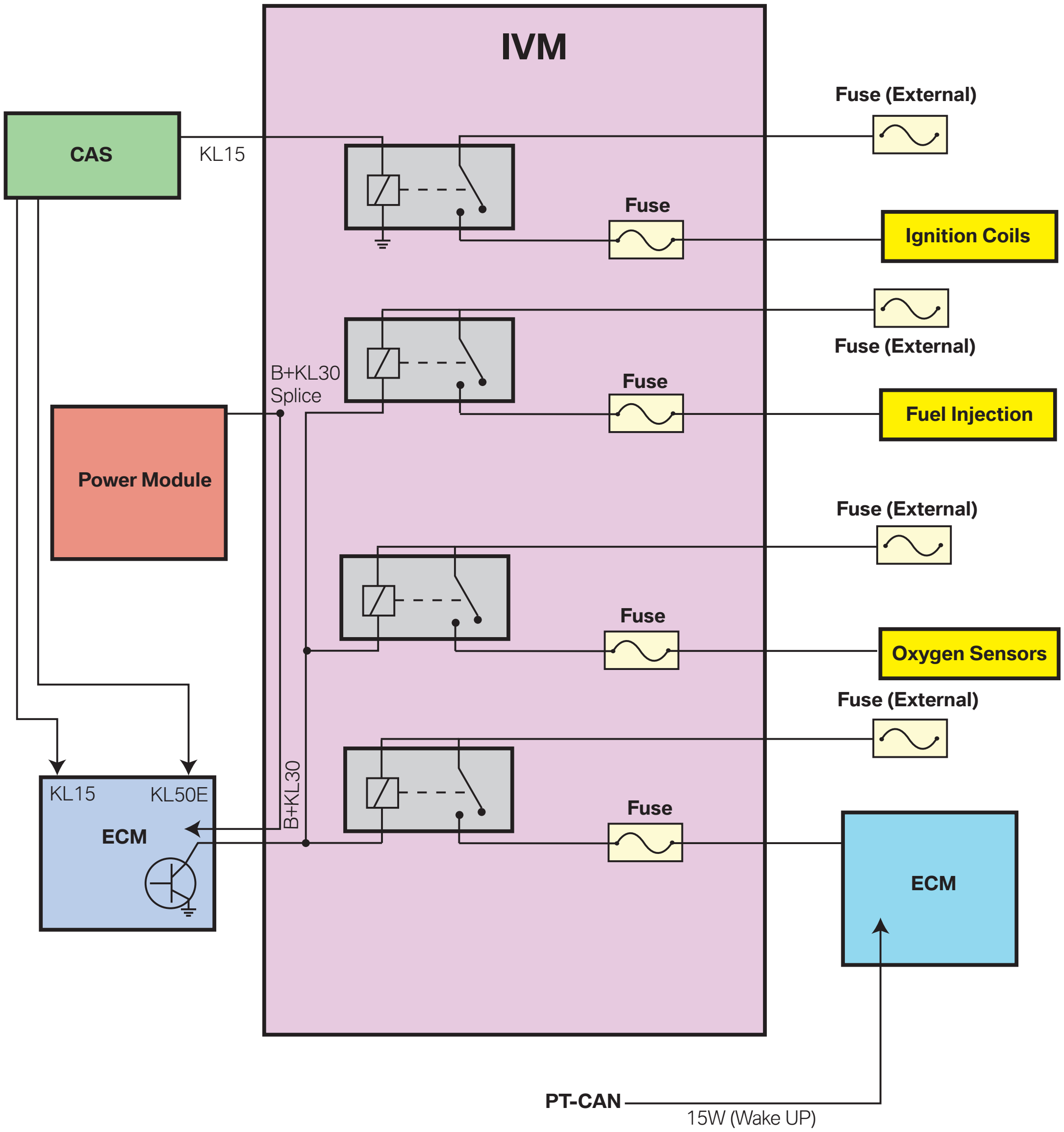
Engine Control Module Relay

ECM Relay Provides the operating Voltage to:	
ECM	Ignition Coil
Fuel Injection	Evaporative Leak Detection Pump
Idle Air Actuator	Camshaft Sensor
Evaporative Emission Valve	Hot Film Air Mass
Fuel Pump Relay	Oxygen Sensor Heaters

Ground: Multiple ground paths are necessary to complete current flow through the ECM.

Integrated Voltage Supply Module (IVM)

The IVM contains integral relays, replaceable fuses and offers a convenient splice point for harness connections. The IVM serves as a central power supply for Engine Management (including VALVETRONIC), Electronic Transmission (EGS) and Dynamic Stability Control (DSC). This diagram is a partial representation of the IVM for Engine Electronics. (FIX COLORS, AND “COLOR” THE IVM)



Principle of Operation

When **KL_15** is switched “ON” the ECM is ready for engine management. The ECM will activate a ground path to energize the Engine Control Module Relays in the IVM (see diagram on the previous page).

- The 1st ECM Relay supplies operating voltage through a fuse (in the IVM) to the ECM.
- The 2nd ECM Relay supplies operating voltage through a fuse (in the IVM) to the Fuel Injectors.
- The 3rd ECM Relay supplies operating voltage through a fuse (in the IVM) to the Oxygen Sensors.

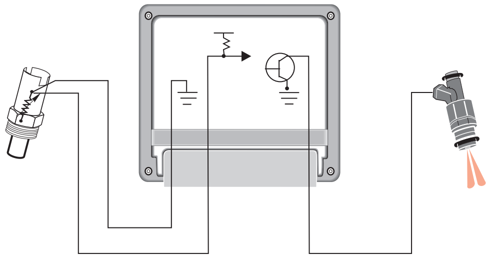
The Ignition Coil Relay (4th relay) is energized by the CAS Module which supplies operating voltage through a fuse (in the IVM) to the Ignition Coils.

The IVM receives high amperage voltage supply from fuses. This supply is for the consumers that are controlled by the IVM internal relays.

When **KL_15** is switched “OFF” the ECM operating voltage is removed. The CAS Module will maintain voltage to the Ignition Coil Relay for a few seconds to maintain ignition coil activation (Emission Optimized - introduced in 2000 MY).

Ground is required to complete the current path through the ECM. The ECM also:

- Internally links a constant ground (1) to the engine sensors.
- Switches ground (2) to activate components.



Battery Voltage

Battery Voltage is monitored by the ECM for fluctuations. It will adjust the output functions to compensate for a lower (6V) and higher (14V) voltage value. For example, the ECM will:

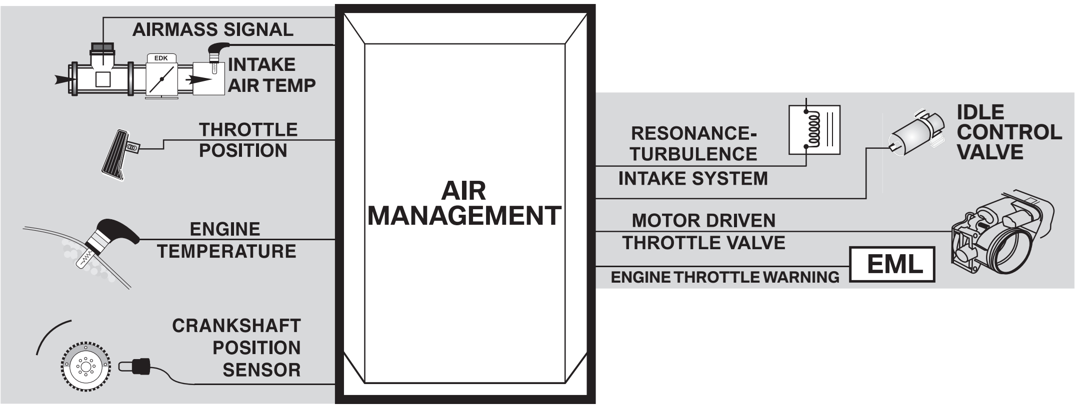
- **Modify pulse width duration of fuel injection**
- **Modify dwell time of ignition**

When **KL_15** is switched “ON” the ECM is ready for Engine Management. The ECM will activate ground to energize the Engine Control Module Relay. The Engine Control Module Relay supplies operating voltage to the ECM and the previously mentioned operating components. Five seconds after the ignition is switched on and the voltage at the KL_15 input is >9 volts, the ECM compares the voltage to the ECM Relay supplied voltage. If the voltage difference between the two terminals is greater than 3 volts, a fault code will be set.

When **KL_15** is switched “OFF” the ECM operating voltage is removed. The ECM will maintain a ground to the Engine Control Module Relay for a few seconds to maintain ignition coil activation (Emission Optimized) and as long as **three minutes to complete the DM-TL test.**

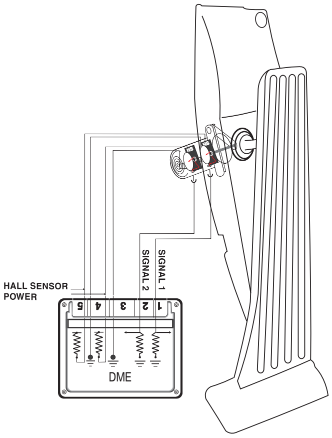
Air Management Overview

Example of IPO for an Air Management System



One of the main purposes of the ECM is Air Management which includes the actuation of several components. In the following pages you will find a generic explanation on how this system works. For more detailed information please access BMW Training Reference Manuals found online.

Air flow into the engine is regulated by the Throttle Valve and/or the Idle Air Actuator. Both of these air "passages" are necessary for smooth engine operation from idle to full load. The Throttle Valve and the Idle Air Actuator are **electrically controlled**. All of the ECM monitoring, processing and output functions are a result of regulated air flow.



Accelerator Pedal Position (Pedalwertgeber - PWG)

The Accelerator Pedal Position is monitored by the ECM for pedal angle position and rate of movement. As the accelerator is moved, it provides two variable voltage signals to the ECM that represents accelerator pedal position and rate of movement.

Dual Hall Sensors are integral in the accelerator pedal module. The ECM compares the two values for **plausibility**. The module contains internal springs to return the accelerator pedal to the rest position.

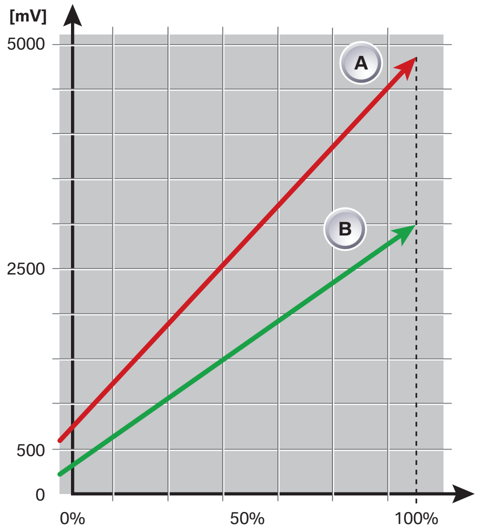
The ECM will increase the volume of fuel injected into the engine, advance the ignition timing and open the Throttle Valve and/or Idle Air Actuator.

The "full throttle" position indicates maximum acceleration to the ECM, and in addition to the functions just mentioned, this will have an effect on the air conditioning compressor.

As the accelerator pedal is released (integral springs), a decrease in voltage signals the ECM to activate fuel shut off if the RPM is above idle speed (coasting). When the Throttle Valve is completely closed, the Idle Air Actuator is opened to maintain engine idle speed.

The ECM monitors the engine idle speed in addition to the accelerator pedal position and throttle position voltage. If the voltage values have changed (mechanical wear of throttle plate or linkage), the ECM will adjust the Idle Air Actuator to maintain the correct idle speed.

The Potentiometers/Hall sensors are non-adjustable because the ECM "learns" the throttle angle voltage at idle speed. If the throttle housing/accelerator pedal module is replaced, the adaptations must be cleared and adaptation procedure must be performed using ISTA. If this is not performed, the vehicle will not start, or run in "fail-safe" mode.



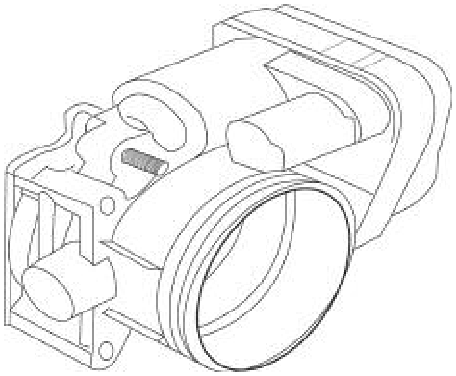
If this input is defective, a fault code will be stored and the "Malfunction Indicator and/or EML" Light will be illuminated. Limited engine operation will be possible.

The ECM provides voltage (5V) and ground for the Hall sensors. As the accelerator pedal is moved from rest to full throttle, the sensors produce a variable voltage signal.

- Hall sensor 1(request)
- Hall sensor 2 (plausibility)

If the signals are not plausible, the ECM will use the lower of the two signals as the requested input. The throttle response will be slower and the maximum throttle response will be reduced.

Throttle Valve (EDK)



The throttle valve plate is electronically operated to regulate intake air flow by the ECM. The main characteristics are:

- Precision throttle operation,
- OBD compliant for fault monitoring,
- DSC and Cruise Control.

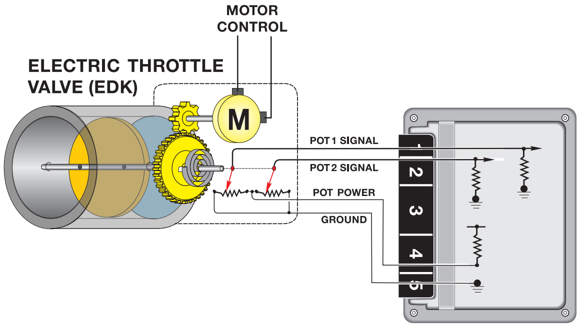
This integrated electronic throttle reduces extra control modules, wiring, and sensors. Adjusting electronic throttles is not permitted, the throttle assembly must be replaced as a unit. The adaptation values must be cleared and adaptation procedure must be performed using ISTA.

The throttle assembly for the system is referred to as the EDK:

- EDK does not contain a PWG, It is remotely mounted (integrated in the accelerator pedal assembly).
- The accelerator pedal is not mechanically “linked” to the EDK.

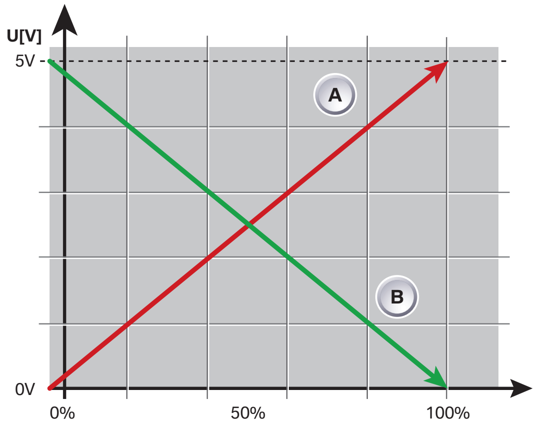
Throttle Motor and Feedback Position

The ECM powers the EDK motor using pulse width modulation (PWM) for opening and closing the throttle plate. The throttle plate is also closed by an integrated return spring.



Two integrated potentiometers provide voltage feedback signals to the ECM as the throttle plate is opened and closed.

- **Feedback signal 1** provides a signal from 0.5V (closed) to 4.5 V (Full Throttle)
- **Feedback signal 2** provides a signal from 4.5V (closed) to 0.5V (Full Throttle)



Potentiometer 1 is the **primary feedback** signal of throttle plate position and signal 2 is the **plausibility cross check** through the complete throttle plate movement.

Total Intake Air Flow Control is performed by the ECM simultaneously operating the EDK throttle control and the Idle Air Actuator.

The ECM detects the driver’s request from the potentiometers/Hall Sensors monitoring the accelerator pedal position. This value is added to the Idle Air control value and the total is what the ECM uses for EDK activation. The ECM then controls the Idle Air Actuator to satisfy the idle air “fill”. In addition, the EDK will also be activated = pre-control idle air charge. Both of these functions are utilized to maintain idle RPM.

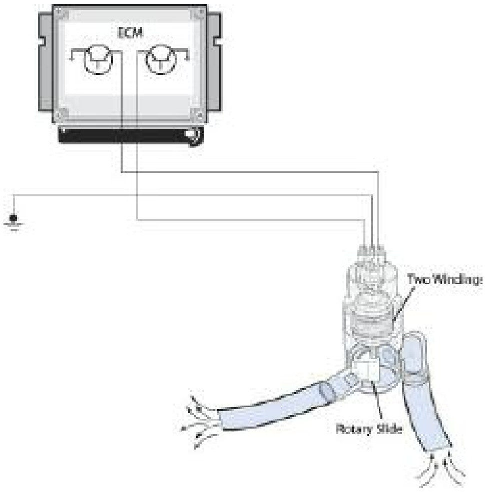
The EDK is electrically held at the idle speed position, and all of the intake air is drawn through the Idle Air Actuator. Without a load on the engine (<15%), the EDK will not open until the extreme upper RPM range. If the engine is under load (>15%), the Idle Air Actuator is open and the EDK will also open.

Failsafe Operation - EDK

When a fault is detected in the system:

- The EDK provides two separate signals from two integrated potentiometers (Pot 1 and Pot 2) representing the exact position of the throttle plate.
- EDK Pot 1 provides the primary throttle plate position feedback. As a redundant safety feature, Pot 2 is continuously cross checked with Pot 1 for signal plausibility.
- If plausibility errors are detected between Pot 1 and Pot 2, the ECM will calculate the inducted engine air mass (from HFM signal) and only utilize the potentiometer signal that closely matches the detected intake air mass.
    - The ECM uses the air mass signaling as a “virtual potentiometer” (Pot 3) for a comparative source to provide failsafe operation.
    - If the ECM cannot calculate a plausible conclusion from the monitored Pots (1 or 2 and virtual 3) the EDK motor is switched off and fuel injection cut out is activated (Failsafe operation is not possible).
- The EDK is continuously monitored during all phases of engine operation. It is also briefly activated/adapted when KL_15 is initially switched on as a “preflight check” to verify it’s mechanical integrity (no binding, appropriate return spring tension, etc). This is accomplished by monitoring both the motor control amperage and the reaction speed of the EDK feedback potentiometers. If faults are detected the EDK motor is switched off and the fuel injection cut off is activated (failsafe operation is not possible). The engine does however continue to run extremely rough at idle speed.
- When in emergency operation, the engine speed is always limited to 1300 RPM by fuel injector cutout, and activation of the “EML” light to alert the driver of a fault.
- When a replacement EDK is installed, the ECM adapts to the new component (required amperage draw for motor control, feedback pot tolerance difference, etc). This occurs immediately after the next cycle of KL_15 for approximately 30 seconds. During this period of adaptation, the maximum opening of the throttle plate is 25%.

Idle Air Actuator



This valve regulates air by-passing the throttle valve to control the engine idle/low speed.

The valve is supplied with battery voltage from the ECM Relay. The Idle Air Actuator is a two-coil rotary actuator. The ECM is equipped with two final stage transistors which will alternate positioning of the actuator.

The final stages are "pulsed" simultaneously by the ECM which provides ground paths for the actuator. The duty cycle of each circuit is varied to achieve the required idle RPM.

If this component/circuits are defective, a fault code will be set and the “Malfunction Indicator Light” will be illuminated when the OBD II criteria is achieved.

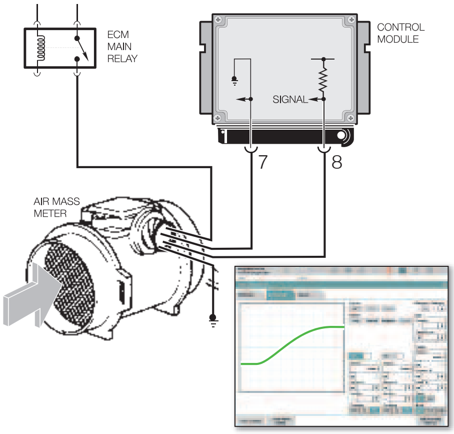
Failsafe Operation - Idle Air Actuator

If a fault is detected with the Idle Air Actuator, the ECM will initiate failsafe measures depending on the effect of the fault (increased air flow or decreased air flow). If there is a fault in the Idle Air Actuator/circuit, the EDK will compensate to maintain idle speed. The “Malfunction Indicator and/or EML” Light will be illuminated to inform the driver of a fault.

If the fault causes increased air flow (actuator failed open), VANOS and Knock Control are deactivated which noticeably reduces engine performance.

Hot-Film Air Mass Meter (HFM)

The air volume input signal is produced electronically by the HFM which uses a heated metal film (180° C above intake air temperature) in the air flow stream.



The ECM Relay provides the operating voltage. As air flows through the HFM, the film is cooled changing the resistance which affects current flow through the circuit. The sensor produces a 1-5 volt varying signal. Based on this change the ECM monitors and regulates the amount of injected fuel.

The Hot-Film Air Mass Meter (HFM) varies voltage monitored by the ECM representing the measured amount of intake air volume. This input is used by the ECM to determine the amount of fuel to be injected.

The heated surface of the hot-film in the intake air stream is regulated by the ECM to a constant temperature of 180° C above intake air temperature. The incoming air cools the film and the ECM monitors the changing resistance which affects current flow through the circuit. The hot-film does not require a “clean burn”, it is self cleaning due to the high operating temperature for normal operation.

If this input is defective, a fault code will be set and the “Malfunction Indicator Light” will illuminate when the OBD II criteria is achieved. The ECM will maintain engine operation based on the Throttle Position Sensors and Crankshaft Position/Engine Speed Sensor.

The HFM is non-adjustable.

Air Temperature Signal

The HFM contains an integral air temperature sensor. This is a Negative Temperature Coefficient (NTC) type sensor. This signal is required by the ECM to correct the air volume input for changes in the intake air temperature (air density) affecting the amount of fuel injected, ignition timing and Secondary Air Injection activation.

The ECM provides the power supply to the sensor which decreases in resistance as the temperature rises and vice versa. The ECM monitors an applied voltage to the sensor that will vary as air temperature changes the resistance value.

If this input is defective, a fault code will be set and the “Malfunction Indicator Light” will be illuminated when the OBD II criteria is achieved. The ECM will operate the engine using the Engine Coolant Sensor input as a back up.

The Air Temperature signal allows the ECM to make a calculation of intake air temperature. The varying voltage input from the NTC sensor indicates the larger proportion of oxygen found in cold air, as compared to less oxygen found in warmer air. The ECM will adjust the amount of injected fuel because the quality of combustion depends on oxygen sensing ratio.

The ignition timing is also affected by air temperature. If the intake air is hot the ECM retards the base ignition timing to reduce the risk of detonation. If the intake air is cooler, the base ignition timing will be advanced. The ECM uses this input as a determining factor for Secondary Air Injection activation.

If this input is defective, a fault code will be set and the “Malfunction Indicator Light” will illuminate when the OBD II criteria is achieved. The ECM will maintain engine operation based on the HFM and Engine Coolant Temperature sensor.

Variable Intake Manifold (DISA)

The intake manifold on the N52 uses a three stage differential intake air system **(DISA)**. The air flow through the intake manifold is controlled and re-directed by two DISA actuator motors.

Each actuator motor is operated by an electric motor controlled by the Engine Control Module (ECM) via a PWM signal. The PWM signal is at a frequency of 200 Hz. The ECM varies the duty cycle to control the position of the DISA flap. The actuator consists of a flap and motor drive. **There are only two positions possible - closed or opened.** When activated, the motor moves the flap to each end position. Both actuators are switched to the closed position at idle.

The DISA motors are similar in design and operation, but they are not interchangeable. Each actuator assembly has it’s own individual part number.

DISA Operation

1st stage - idling/lower engine speed range

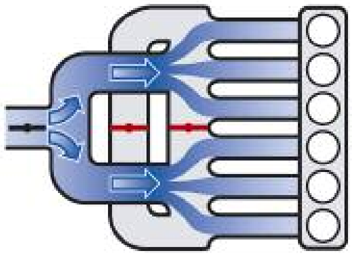
At idle speed and in the lower engine speed range, actuators 1 and 2 are closed. The intake air flows past the throttle valve into the resonance pipe. In the resonance pipe, the intake air mass splits. The air is fed via the collector pipe and resonating pipes into the individual cylinders. In this way, three cylinders are provided with a comparably high air mass.

2nd stage - medium engine speed range

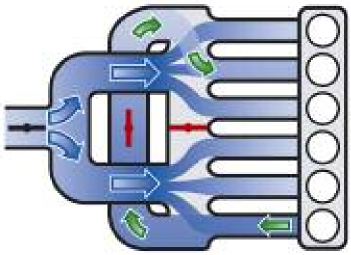
In the medium engine speed range, DISA actuator motor 2 is opened. In this case, it is assumed that the inlet valves of the first cylinder are just closing. The gas motion creates a pressure peak at the closing inlet valves. This pressure peak is passed on via the resonating and collector pipes to the in next cylinder in the firing order. This improves the fresh gas filling of the next cylinder to be filled.

3rd stage - upper engine speed range

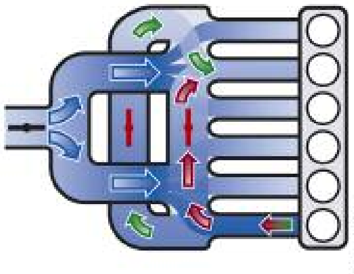
In the upper engine speed range, both DISA actuator motors are opened. In this case, it is assumed that the inlet valves of the first cylinder are just closing. The gas motion creates a pressure peak in front of the closing inlet valves. The intake air mass is now fed via the resonating, overshoot and collector pipes.



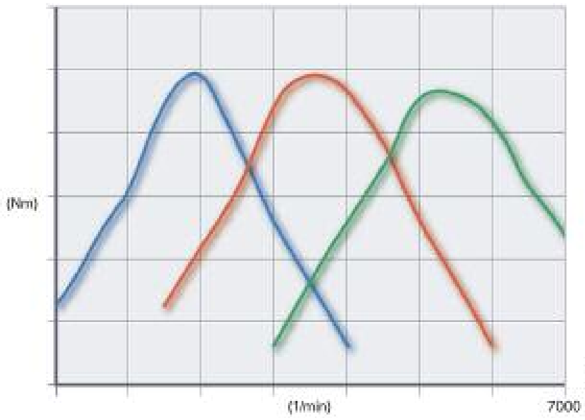
1st Stage



2nd Stage

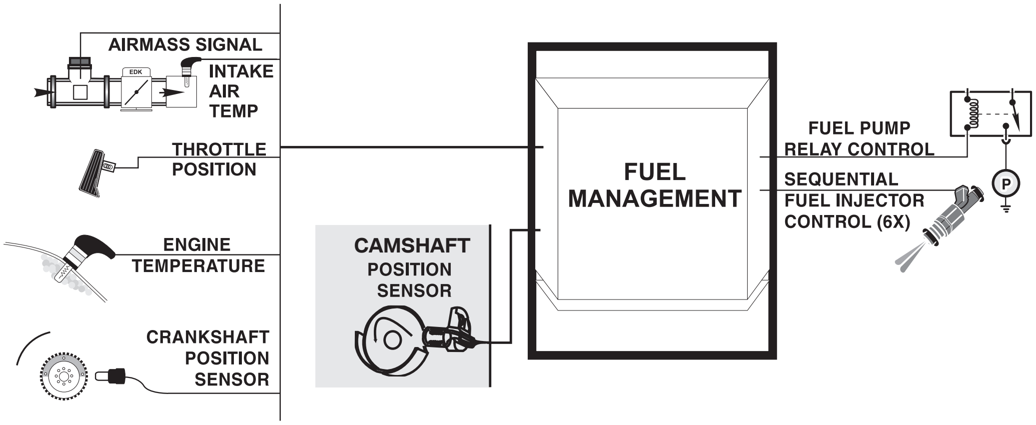


3rd Stage



Fuel Management Overview

Example of IPO for a Fuel Management System



One of the main purposes of the ECM is Fuel Management which includes the actuation of several components. In the following pages you will find a generic explanation on how this system works. For more detailed information please access BMW Training Reference Manuals found online.

Fuel Delivery Unit

The fuel delivery unit is located inside the fuel tank. It consists of the following:

In the right half of the fuel tank

Fuel baffle with electric fuel pump (EKP), right fuel level sensor and right suction jet pump.

In the left half of the fuel tank

Fuel filter with pressure regulator, left fuel level sensor and left suction jet pump.

The components are firmly connected to the respective service cover. When replacing the electric fuel pump, it can be removed from the fuel tank complete with the service cover, fuel baffle, suction jet pump and fuel level sensor.

Fuel Supply

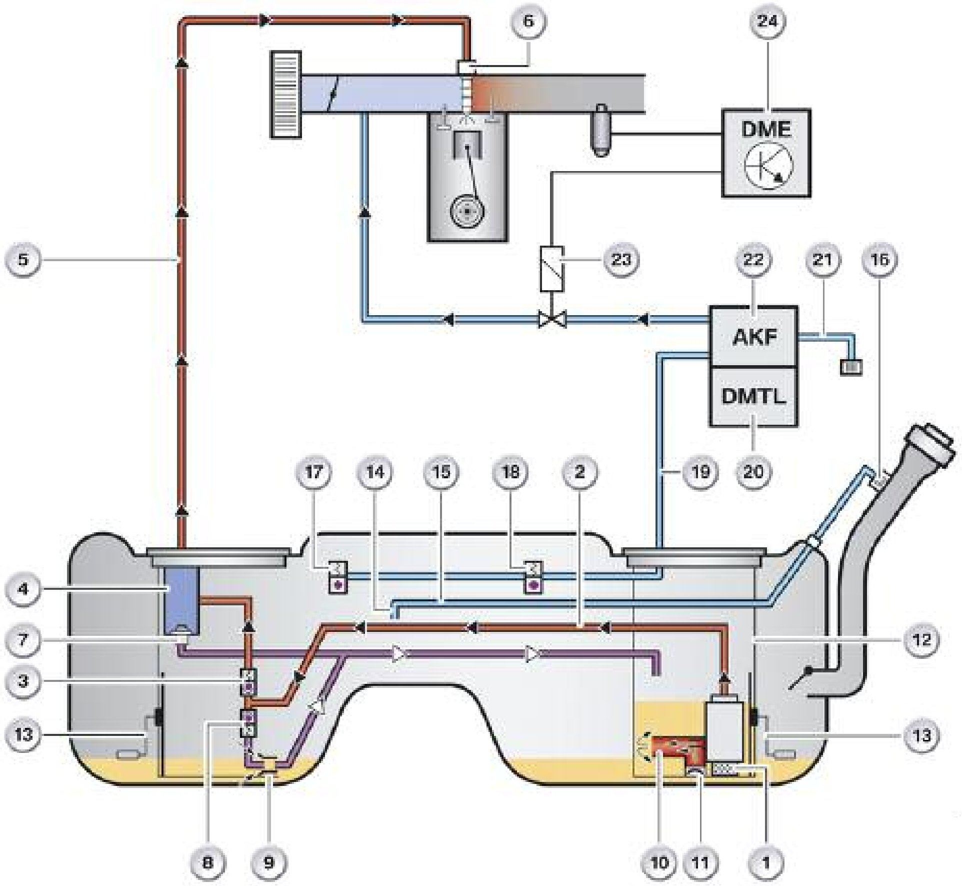
The fuel is delivered from the fuel tank to the engine in the following sequence:

- From the right half of the fuel tank;
- through the initial filler valve (11);
- into the fuel baffle (12);
- from the electric fuel pump (1);
- via a T-piece, on the one side, through the check valve (3) into the fuel filter (4);
- through the feed line (5) in the left-hand service opening to the engine;
- and, on the other side, via the check valve (8) to the left-hand suction jet pump (9) back into the fuel baffle;
- parallel from the electric fuel pump to the right-hand suction jet pump (10);
- and from the right half of the fuel tank into the fuel baffle.

The fuel filter (4) and pressure regulator (7) are located at the left-hand service opening. The check valve (8) opens at a fuel pressure above 2.5 bar. It ensures the engine receives sufficient fuel before the left suction jet pump cuts into the circuit.

As an example, on the N52 engine the pressure regulator (7) routes the fuel back into the fuel baffle (12). A 5 bar pressure regulator is used for vehicles with the N52 engine.

N52 Fuel Supply



Index	Explanation	Index	Explanation
1	Electric Fuel Pump	13	Fuel Level Sensor
2	Feed Line	14	Refuelling Line Connection Piece
3	Check Valve	15	Refuelling Ventilation Line
4	Fuel Filter	16	Refuelling Ventilation
5	Feed Line to Engine	17	Left Operation Ventilation Valve
6	Fuel Injector	18	Right Operation Ventilation Valve
7	Pressure Regulator	19	Operation Ventilation Line
8	Check Valve	20	Diagnosis Module for Tank Leakage (DM-TL)
9	Left Suction Jet Pump	21	Atmosphere Line
10	Right Suction Jet Pump	22	Carbon Canister
11	Initial Filling Valve	23	Fuel Tank Vent Valve
12	Fuel Baffle	24	Digital Motor Electronics

Electric Fuel Pump

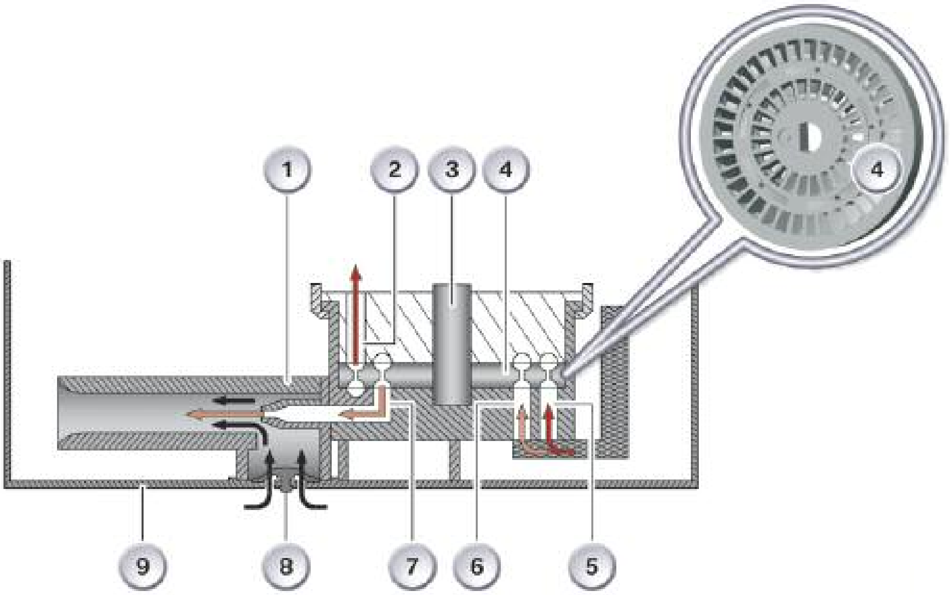
The electric fuel pump delivers fuel simultaneously through two separate circuits into a main channel and a secondary channel.

The main channel is used for conveying fuel to the fuel supply system. The secondary channel supplies the right hand suction jet pump with fuel.

Channels are located above the pump wheel, in which a helical flow circulation is produced by the position of the delivery blades.

The fuel is thus conveyed from the intake side to the outlet side. An electric fuel pump with increased output is used and has a maximum pressure of 5bar (N52, N54, N55, N63, N74).

On Engines with Direct Injection (N54, N55, N63, N73 and N74), this low fuel pressure pump feeds the high fuel pressure pump(s) with maximum pressures typically between 50 and 200bar.

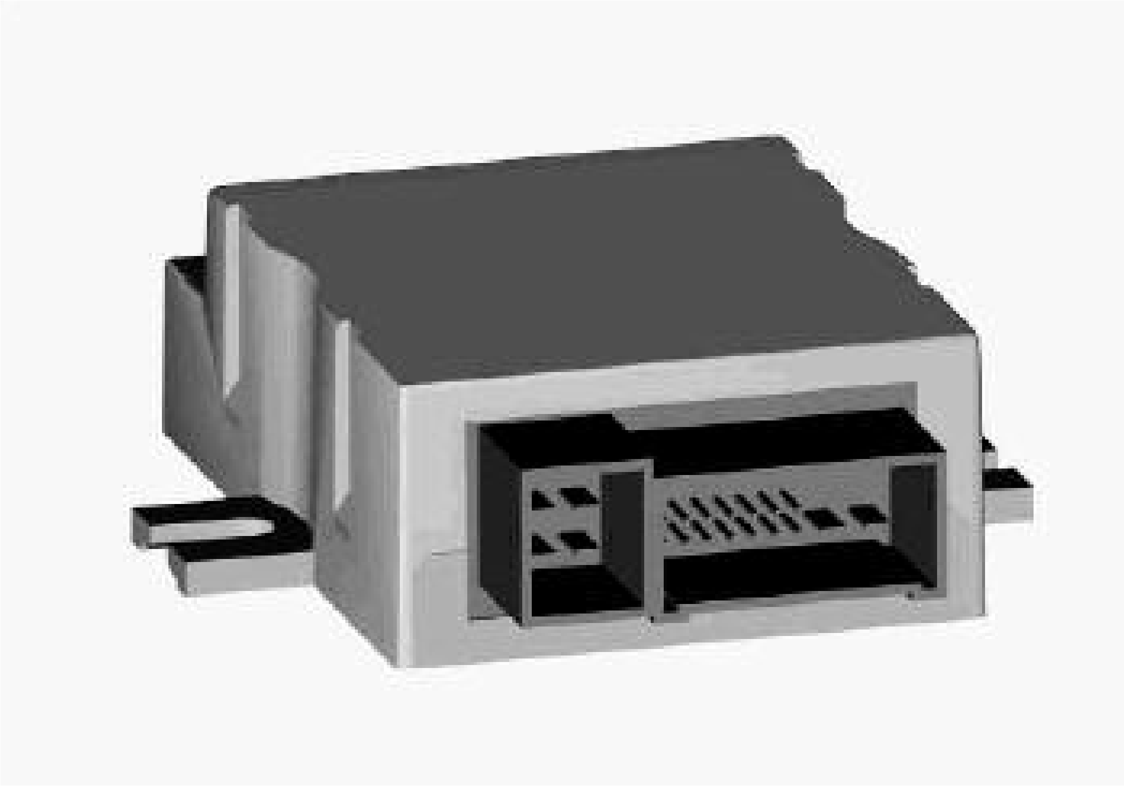


Index	Explanation	Index	Explanation
1	Suction jet pump	6	Intake opening, secondary channel
2	Main channel in supply	7	Secondary channel to suction jet pump
3	Driveshaft from electric motor	8	Initial filling valve
4	Impeller	9	Fuel baffle
5	Intake opening, main channel		

Fuel Pump Control

In conventional systems, the electric fuel pump is operated continuously at maximum speed using the highest on-board supply voltage available. The maximum amount of fuel that may be required is made available regardless of the operating conditions.

The fuel pump control is managed by the EKP module. The fuel pump is a variable speed controlled unit which means the EKP module only supplies the required fuel for engine operation thus eliminating excess fuel delivery. This arrangement also reduces pump wear and running losses are kept to a minimum.



In this case, EKP stands for the "Electronic fuel pump control" system. The EKP abbreviation is often used to refer to the electric fuel pump itself. The electronically controlled fuel pump system described here is controlled by a control unit called the EKP control unit. The abbreviation EKP is used here to refer to the system as a whole.

Principle of Operation

Fuel Management delivers fuel from the tank to the intake ports of the engine. To accomplish this, fuel supply must be available to the fuel injectors. Then the fuel must be injected in the precise amount and at the correct time. The ECM does not directly monitor fuel supply, although it does control it. The ECM controls and monitors fuel injection.

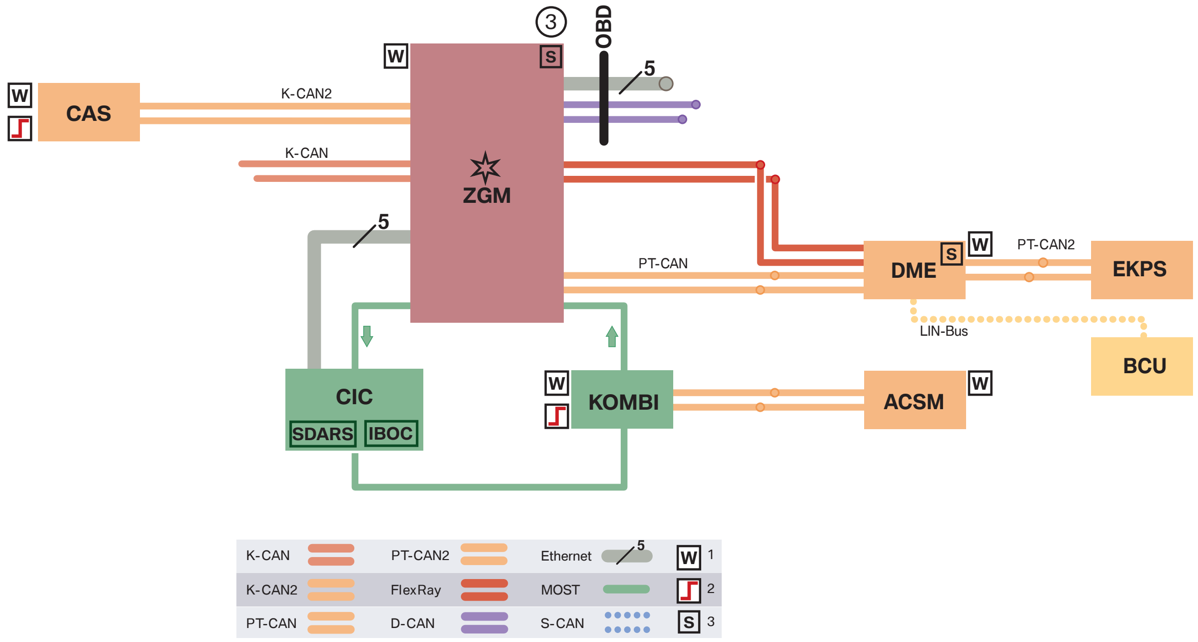
The ECM (DME) is connected to the EKP module via the PT-CAN network via a pulse width modulated (PWM) signal according to the fuel quantity required by the ECM. The electric fuel pump in the EKP system is activated as required. The DME calculates the amount of fuel required at the given point in time. The total volume required is transmitted as a message to the EKP control unit via PT-CAN.

The EKP control unit controls the electric fuel pump on the basis of mappings so that the electric fuel pump delivers the exact amount of fuel required.

The EKP control unit converts this message into an output voltage. This output voltage is then used to control the speed of the electric fuel pump. This achieves a delivery which corresponds with the requirements.

The illustrations shown below are from an E90 and an F10. The EKP module on the E90 contains one of the terminating resistors for the PT-CAN.

F10 Fuel Requirement Signal Path



Fuel requirement mappings are stored in the EKP control unit. The fuel requirement mappings are encoded for each specific engine and model. The EKP control unit uses the mappings as the basis on which to calculate the total amount of fuel to be delivered from the following variable:

- Amount of fuel required by the engine (request from the ECM). This results in a pulse-width modulated output voltage from the EKP control unit. The output voltage of the EKP control unit is the supply voltage for the electric fuel pump. The EKP control unit controls the speed of the electric fuel pump via the supply voltage. The EKP control unit controls the speed by comparing the actual speed with the specification.

The current speed of the electric fuel pump is calculated as follows:

The EKP control unit sends the current supply to the fuel pump (pulse-width modulated). This voltage is absorbed as a specific ripple due to the individual armature windings of the rotating electric motor. The ripple corresponds with the number of segments in the commutator which corresponds with the number of armature windings in the electric motor.

The number of waves produced per revolution is equal to the number of existing commutator segments.

This means that the EKP control unit can employ a patented procedure - "Ripple Counter" as the basis for calculating the actual speed of the fuel pump using power consumption ripple.

Coding and Programming

The data for the electronically controlled fuel pump system is encoded as follows:

- In the ECM (DME), the engine and model-related characteristic curves for fuel delivery according to requirements.
- In the EKP control unit: specific characteristic curves for the relevant fuel system

Failsafe Operation

If the fuel quantity requirement from the ECM and/or the EKP rotation speed signal fails, the fuel pump will continue to operate with the greatest delivery rate (100%) when terminal KL_15 is activated. This guarantees fuel supply even if the control signals fail.

Fuel Injectors/Fuel Rail

The type of fuel injector depends on the engine design. BMW for the most part utilizes two different configurations:

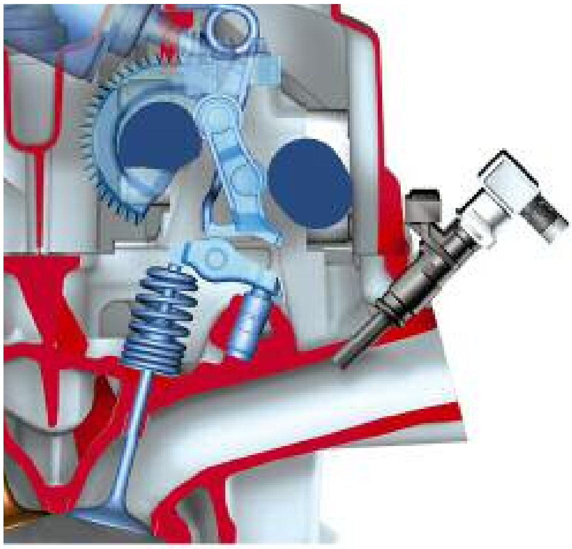
- Injectors mounted into the cylinder head spraying fuel into the intake port and;
- Injectors mounted into the cylinder head spaying fuel directly into the combustion chamber, also known as **Direct Injection**.

Furthermore, BMW uses two different types of injectors:

- Solenoid Injector (in low and high pressure systems)
- Piezo Injector (only used in high pressure systems)

In Normally Aspirated (NA) engines like the N52, due to the wider design of the cylinder head, the fuel injectors are not located in the intake manifold as on previous 6-cylinder engines. This is why, as mentioned earlier, the injectors are now mounted into machined bore in the cylinder head. This design allows the injectors to be closely mounted to the intake valves.

N52



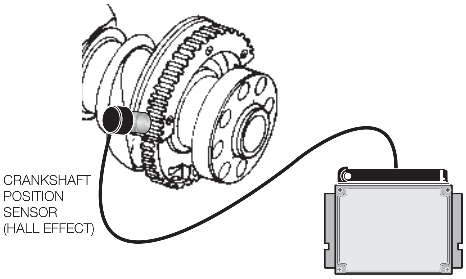
N54

Power supply for the fuel injectors is from Terminal KL_87 of the fuel injector relay.

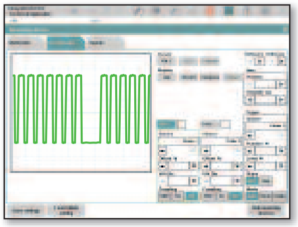
The fuel rail is a non-return design which includes a service port for diagnosis.

Crankshaft Position/RPM Sensor (Hall Effect)

A Hall Sensor provides the crankshaft position and engine speed (RPM) signal to the ECM for fuel pump and Injector operation.



The Hall sensor is supplied with voltage from the ECM. A digital square wave signal is produced by the sensor as the teeth of the impulse wheel pass by. The “gap” allows the ECM to establish crankshaft position.



**SMOOTH RUNNING ENGINE
(NOTE SQUARE WAVE SIGNAL)**

**The crankshaft position sensor is monitored as part of OBD II requirements for Misfire Detection. If this input is faulty, the ECM will operate the engine (limited driveability) from the Camshaft Sensor input.
A fault with this input will produce the following complaints:**

- **Hard Starting/Long Crank Time**
- **“Malfunction Indicator Light”**
- **Driveability/Misfire/Engine Stalling**

Intake and Exhaust Camshaft Sensors

"Static" Hall sensors are used so that the camshaft positions are recognized once ignition is on (KL_15) before the engine is started. The main functions of the intake cam sensor are:

- Cylinder “work cycle” for injection timing;
- Synchronization;
- Engine speed sensor (if crankshaft speed sensor fails);
- VANOS position control of the intake cam.

If these sensors fail there are no substitute values, the system will operate in the failsafe mode with no VANOS adjustment. The engine will still operate, but torque reduction will be noticeable. Use caution on repairs as not to bend the impulse wheels.

The two camshaft sensors are mounted into the cylinder head and monitor the impulse wheels which are bolted to the front of the VANOS units.

Power is supplied to the sensors via the engine electronics fuses. Ground is supplied via the ECM. The sensors are hall effect and provide the ECM with a 5V square wave signal.

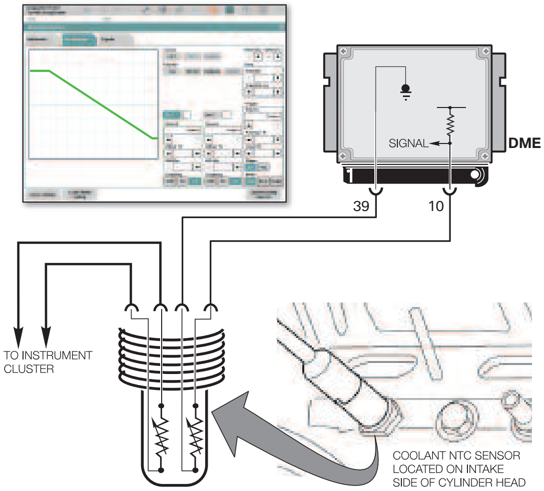
Camshaft Sensor

Camshaft Sensor Trigger Wheel

Engine Coolant Temperature

The Engine Coolant Temperature is provided to the ECM from an NTC type sensor located in the coolant jacket of the cylinder head. The sensor contains two NTC elements, the other sensor is used for the instrument cluster temperature gauge.

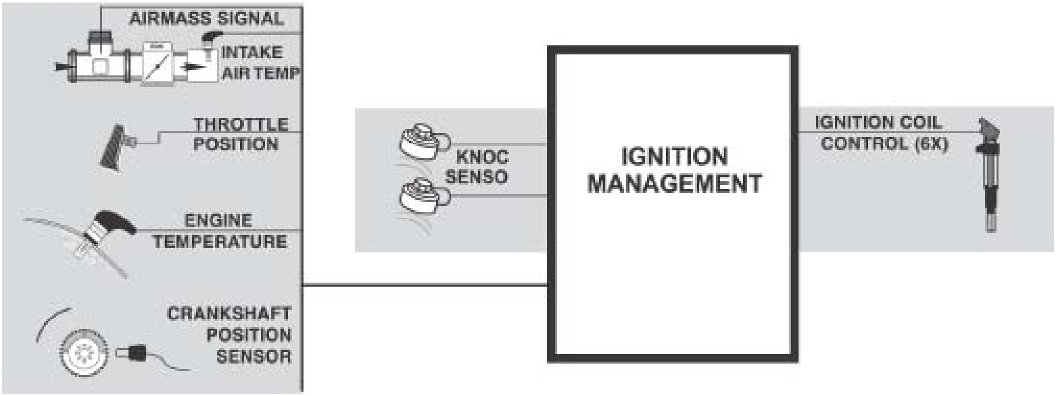
The ECM determines the correct air/fuel mixture required for the engine temperature by monitoring an applied voltage to the sensor (5V). This voltage will vary (0-5V) as coolant temperature changes the resistance value.



If the Coolant Temperature sensor input is faulty, a fault code will be set and the ECM will assume a substitute value (80°C) to maintain engine operation.

Ignition Management Overview

Example of IPO for an Ignition Management System



One of the main purposes of the ECM is Ignition Management which includes the actuation of several components. In the following pages you will find a generic explanation on how this system works. For more detailed information please access BMW Training Reference Manuals found on-line.

Ignition System Inputs

The ignition system on the engine management system uses several inputs to control ignition functions. Proper ignition timing control is dependent upon inputs such as RPM, throttle position, crankshaft position, air mass and temperature (coolant and intake air) and in our turbocharged engines, intake boost pressure.

Ignition Coils

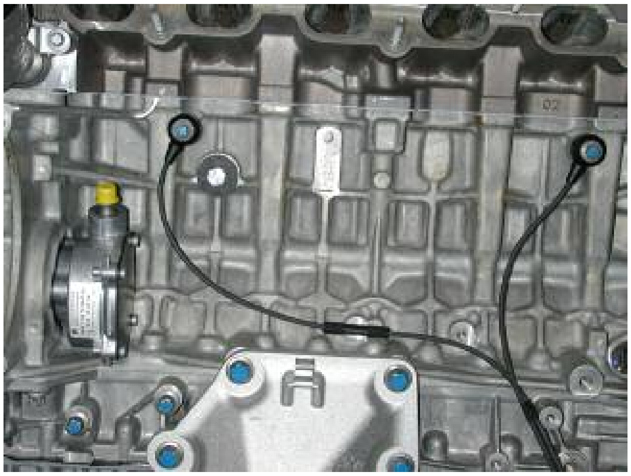
The ignition coils are the familiar “pencil” type. The secondary ignition “boot” and resistor are integrated into the coil housing.

Spark Plugs

The spark plugs used on BMW Engines are designed by NGK. The plugs use an Iridium center electrode. The center electrode is only 0.6 mm thick. The insulator is also redesigned. The new spark plug technology allows for longer service life and improved cold starting.

Iridium is a precious metal that is 6 times harder and 8 times stronger than platinum, it has a 1,200° F higher melting point than platinum and conducts electricity better.

Knock Sensors



The knock sensors operate on the piezo electric principle. Vibrations from combustion events are converted into electrical signals which are monitored by the ECM. Excessive vibration indicates engine knock which will cause the ECM to retard the ignition timing to retard as necessary

Excessive knocking will cause the MIL to illuminate.

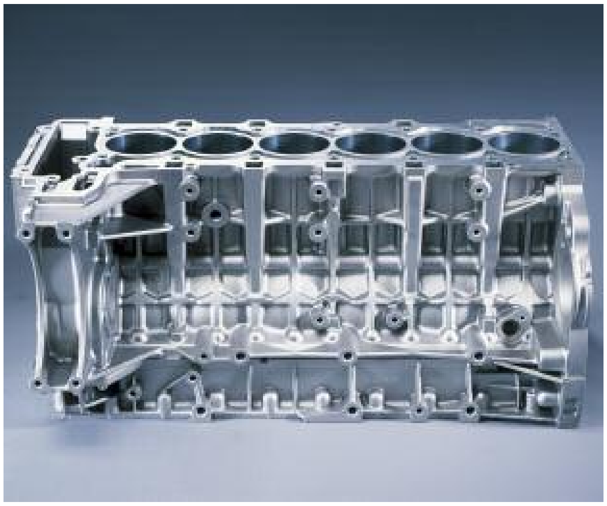
When installing knock sensors, be sure to torque to specification. Under or over-tightening the knock sensors can result is erroneous knock sensor faults or poor engine performance.

Crankshaft Position/RPM Sensor (Hall Effect)

The crankshaft position sensor provides the ECM with a 5 volt square wave signal. The ECM calculates engine speed (RPM) and crankshaft position for ignition and injection system operation.

The sensor is supplied with 12 volts from the engine electronics fuses and ground from the ECM.

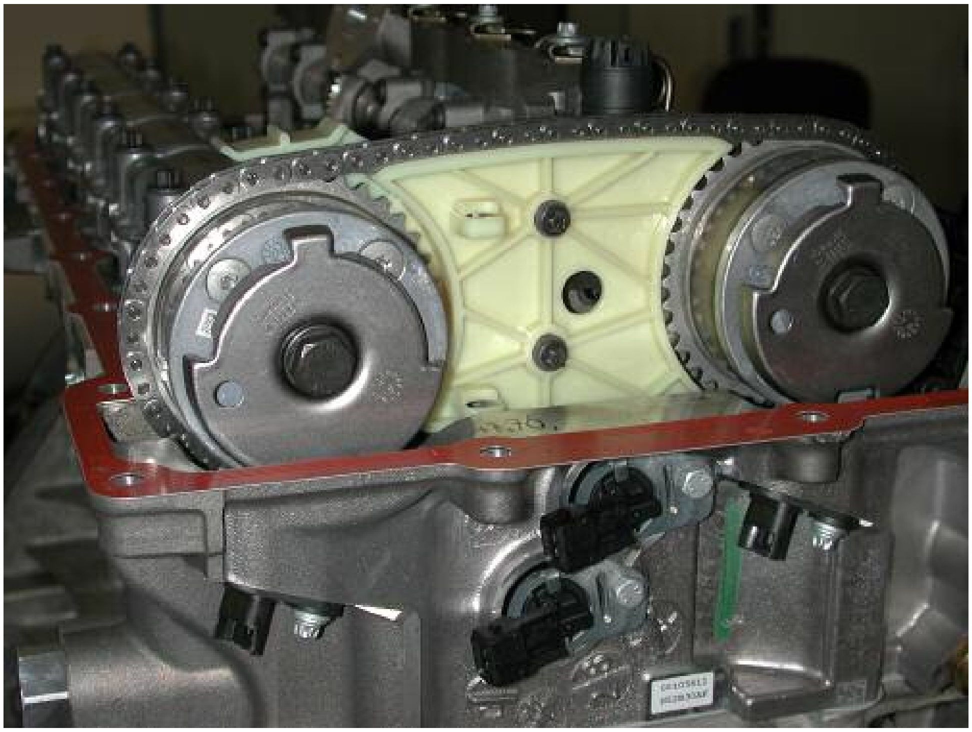
The crankshaft position sensor is also monitored for variations in crankshaft speed to determine misfires.



VANOS Overview

Performance, torque, idle characteristics and exhaust emissions reduction are improved by Variable Camshaft Timing. The VANOS system on the N52 is weight optimized and is similar in design to the VANOS on the N62.

The Vanos units are mounted directly on the front of the camshafts and adjusts the timing of the Intake and Exhaust camshafts throughout the entire spread range from retarded to advanced. The ECM controls the operation of the VANOS solenoids which regulates the oil pressure required to move the VANOS units. Engine Rpm, load and temperature are used to determine VANOS activation.

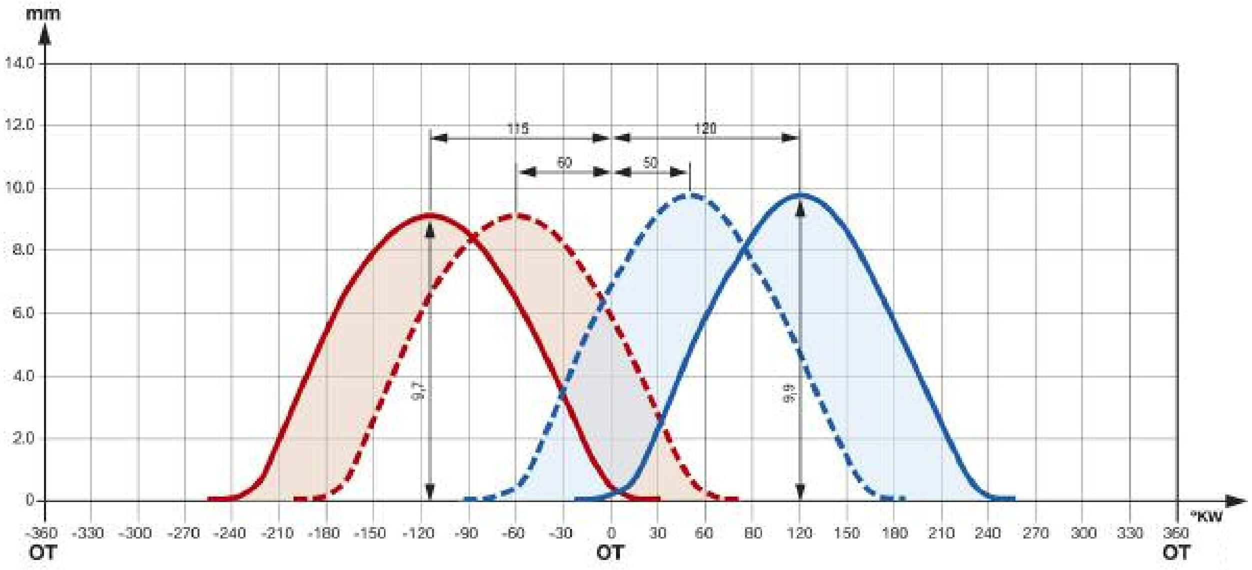


The VANOS mechanical operation is dependent on engine oil pressure applied to position the VANOS units. When oil pressure is applied to the units (via ports in the camshafts regulated by the solenoids), the camshaft hubs are rotated in the drive sprockets changing the position which advances/retards the intake/exhaust camshafts timing. The VANOS system is “fully variable”. When the ECM detects that the camshafts are in the optimum positions, the solenoids maintain oil pressure on the units to hold the camshaft timing.

The operation of the VANOS solenoids are monitored in accordance with the OBD II requirements for emission control. The ECM monitors the final stage output control and the signals from the Camshaft Position Sensors for VANOS operation.

Note: Currently all BMW engines feature Double VANOS.

N55 valve timing diagram



		N54B30O0	N55B30M0
Intake valve Ø	[mm]	31.4	32
Exhaust valve Ø	[mm]	28	28
Maximum valve lift, intake valve/exhaust valve	[mm]	9.7/9.7	9.9/9.7
Intake camshaft spread (VANOS adjustment range)	[°crankshaft]	55	70
Exhaust camshaft spread (VANOS adjustment range)	[°crankshaft]	45	55
Intake camshaft opening angle (max.-min. spread)	[°crankshaft]	125 - 70	120 - 50
Exhaust camshaft opening angle (max.-min. spread)	[°crankshaft]	130 - 85	115 - 60
Opening period intake camshaft	[°crankshaft]	245	255
Opening period exhaust camshaft	[°crankshaft]	261	261

Note: The N55 has a larger intake and exhaust VANOS adjustment range as well as larger intake valve lift, and cam duration than the N54 engine.

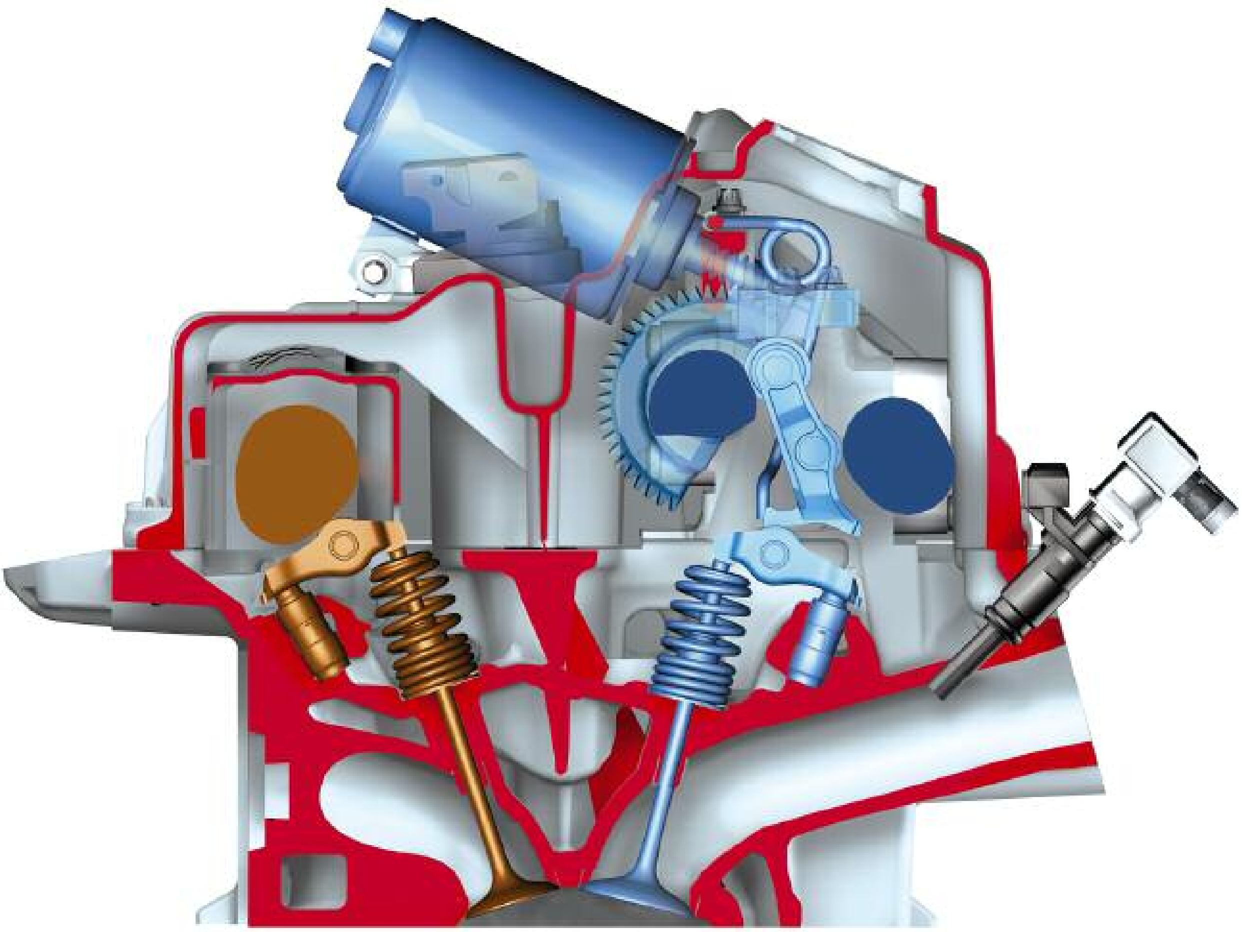
VALVETRONIC Overview

Since the introduction of the N52, the 6-cylinder engine is now also equipped with the load control system based on the valve timing gear. The VALVETRONIC I system that was used on the 8 and 12-cylinder engines already achieved a substantial increase in efficiency.

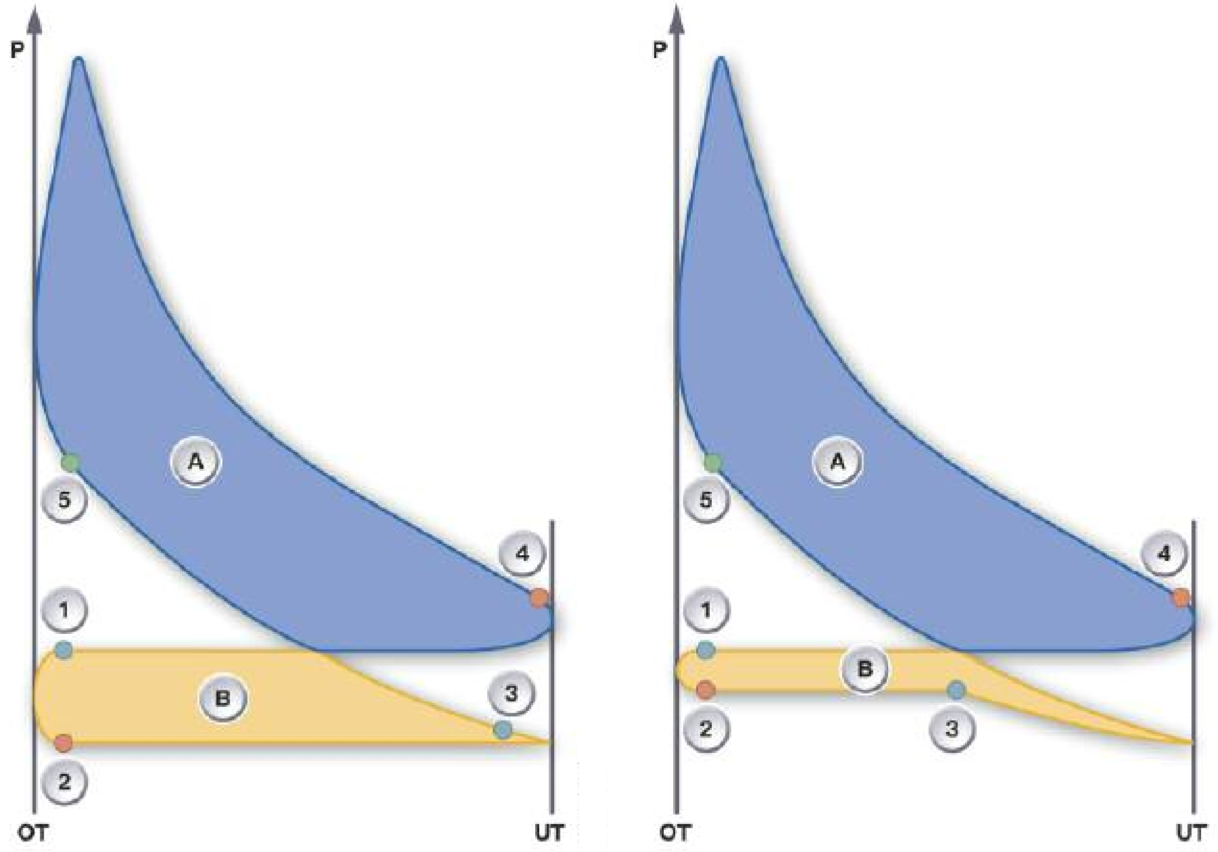
BMW has further developed this concept with the VALVETRONIC II.

The results of this further development are:

- Increased engine dynamics
- Increased efficiency
- Improved emission values



Load Control



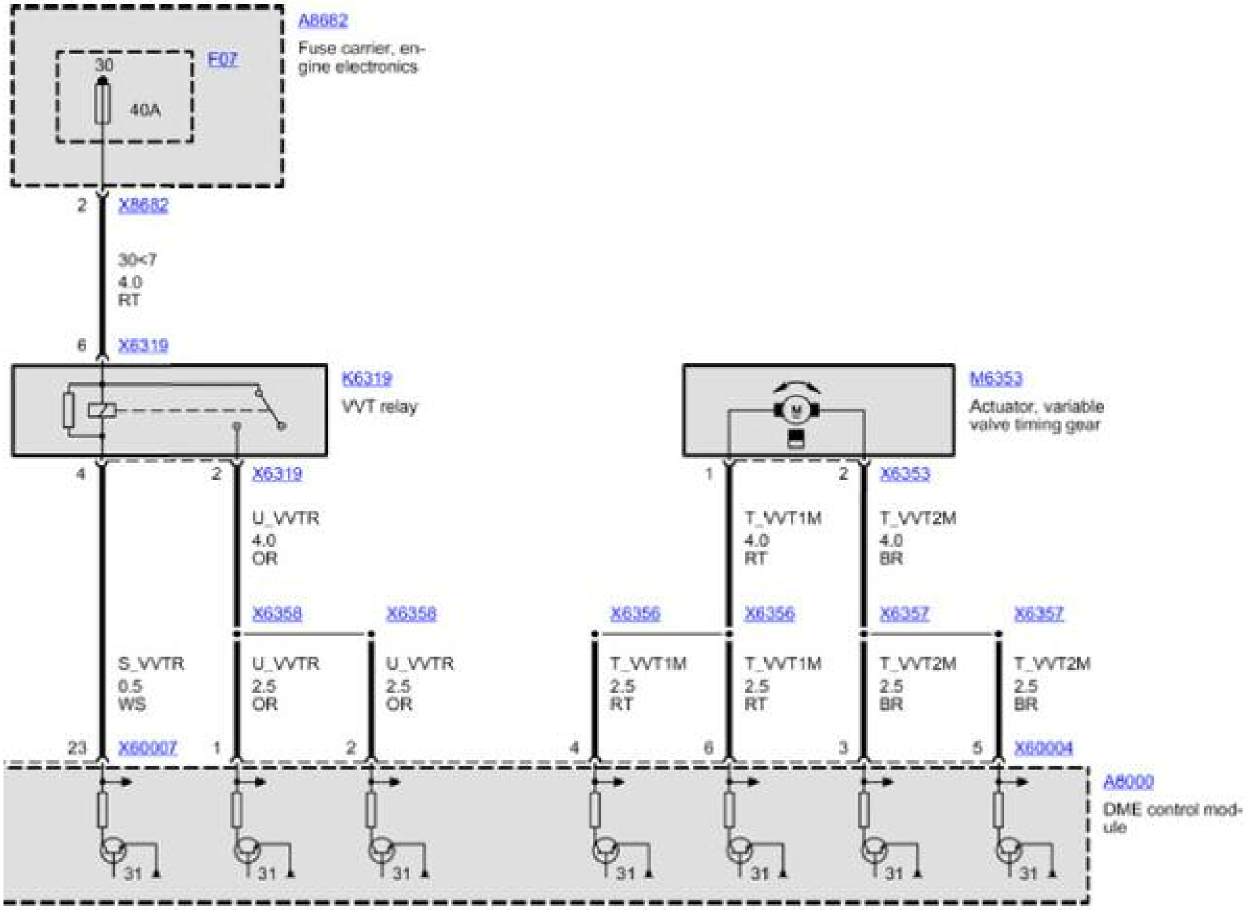
Index	Explanation	Index	Explanation
OT	Top dead center	4	Exhaust valve opens
UT	Bottom dead center	5	Firing point
1	Intake valve opens	A	Gain
2	Exhaust valve closes	B	Loss
3	Intake valve closes	P	Pressure

The illustration on the left shows the conventional method with the higher loss. The reduced loss can be clearly seen in the illustration on the right. The upper area represents the power gained from the combustion process in the petrol engine. The lower area illustrates the loss in this process.

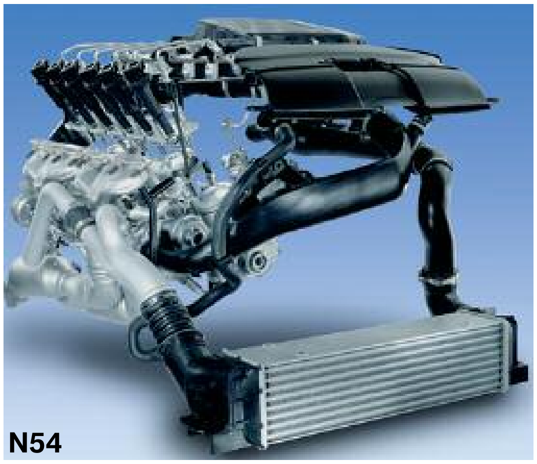
The loss area can be equated to the charge cycle, relating to the amount of energy that must be applied in order to expel the combusted exhaust gasses from the cylinder and then to draw the fresh gasses again into the cylinder.

VVT Motor

As an example, on the N52 engine the VVT motor is controlled directly by the ECM. The motor receives power from a relay located in the E-box.



Turbocharging Technology Overview


N54

Until now, BMW has built a reputation for building high performance engines which are naturally aspirated. Much research has gone into the development of an efficient engine design which meets not only the expectations of the customer, but complies with all of the current emissions legislation.

Currently, the global focus has been centered around the use of alternative fuels and various hybrid designs. While BMW recognizes these concerns, there is still much development to be done on the internal combustion engine. Therefore, BMW will continue to build some of best internal combustion engines in the world.

That is why in 2006 BMW introduced the N54 engine as the first turbocharged powerplant in the US market. In addition to turbocharging, the N54 features second generation direct injection and Double-VANOS.

As far as gasoline engines are concerned, turbocharging has not been in widespread use at BMW, that is until now. As a matter of fact, the last turbocharged BMW production vehicle was the E23 (745i) which was not officially imported into the US. The previous “turbo” model before that was the legendary 2002 tii turbo in the early 1970’s. This 2002 tii turbo was also not officially imported into the US.

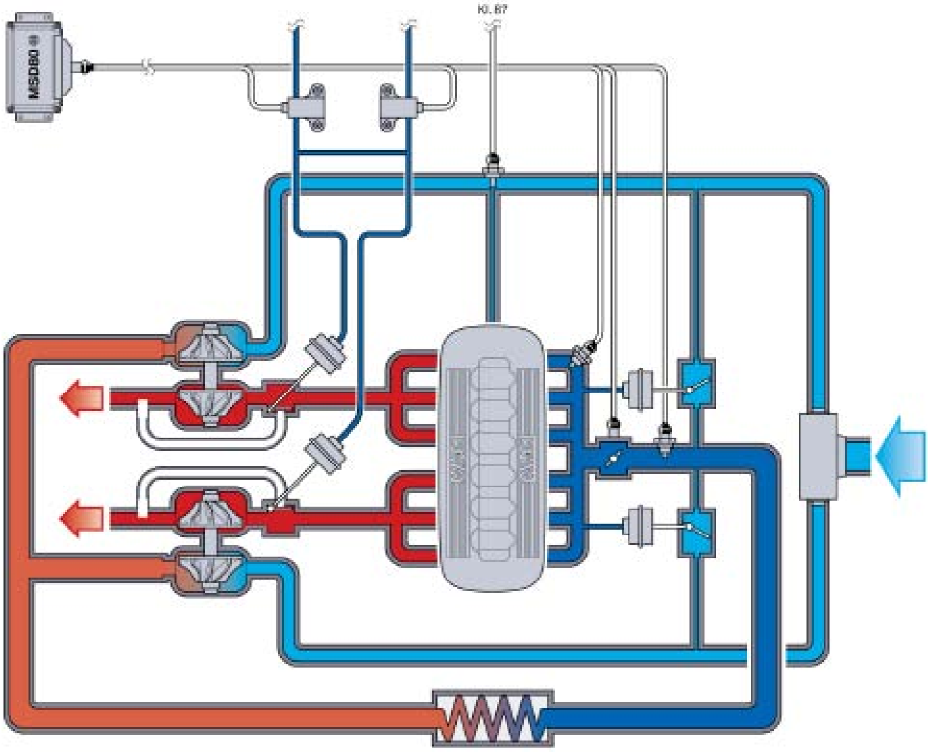
Principles of Operation

The turbocharger consists of a turbine and compressor assembly on a common shaft inside of the turbocharger housing. A turbocharger is driven by waste (exhaust) gasses and in turn drives a compressor which forces air into the engine above atmospheric pressure. This increase pressure allows for an air charge with a greater density. The result is increased torque and horsepower. The turbine and the compressor can rotate at speeds of up to 200,000 rpm and the exhaust inlet temperature can reach max temperatures of up to 1050°C.

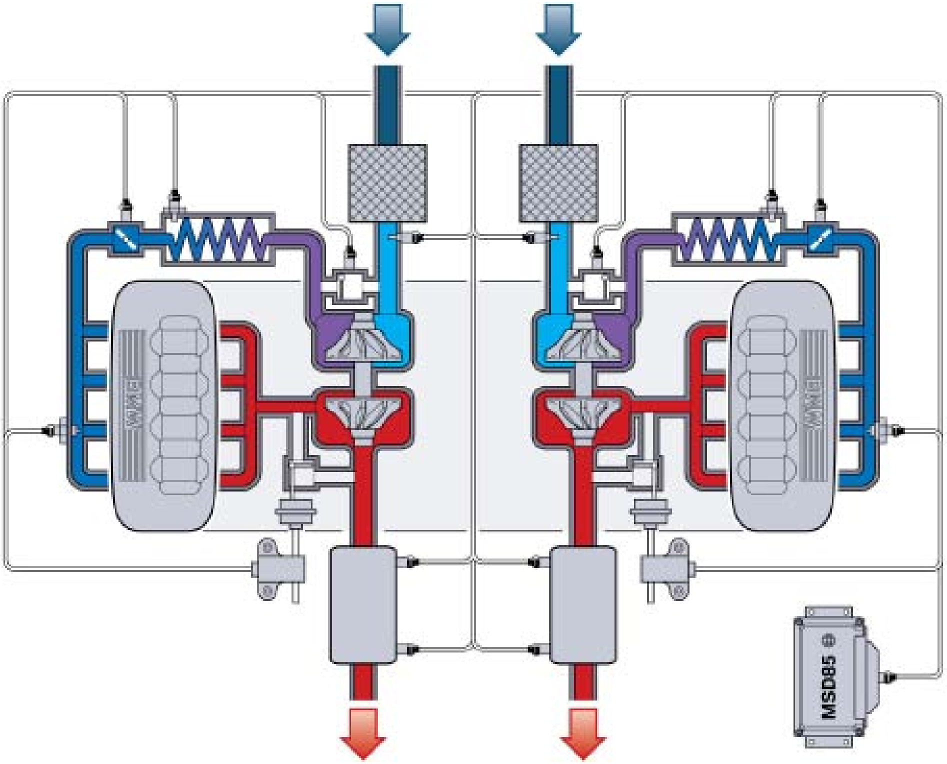
This increased density during the intake stroke ultimately adds up to the creation of more engine output torque. Of course, this increased density must be accompanied by additional fuel to create the desired power. This is accomplished by engine management system programming to increase injector “on-time” and enhance associated maps.

The use of an exhaust driven turbocharger is used to create more engine power through increased efficiency. In the case of BMW turbocharged engines, the turbocharger is used in conjunction with direct fuel injection. This provides the best combination of efficiency and power with no compromise.

N54 Turbo schematics



N63 Turbo schematics

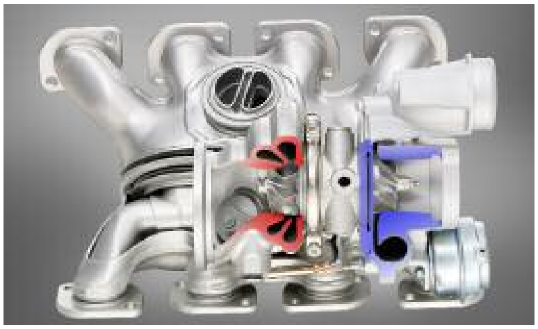


Bi-turbocharging

A major advantage of the smaller-sized turbochargers is their low moment of inertia. Even the slightest impetus given by the driver with the accelerator pedal receives a response with an immediate build-up of pressure. The lag typically experienced until now in turbocharged engines - i.e. the time it takes for the turbocharger to attain its power-delivering effect - is thus no longer perceptible.

This requirement is met in the N54 engine with two small turbochargers, which are connected in parallel. Cylinders 1, 2 and 3 (bank 1) drive the first turbocharger (5) while cylinders 4, 5 and 6 (bank 2) drive the second (2). The advantage of a small turbocharger lies in the fact that, as the turbocharger runs up to speed, the lower moment of inertia of the turbine causes fewer masses to be accelerated, and thus the compressor attains a higher boost pressure in a shorter amount of time.

Twin-scroll Turbo System



The response characteristics of the use of twin-scroll exhaust turbochargers are enhanced when compared to the single-scroll turbos. For example, the S63’s turbocharger turbines are fed through two separate channels within the turbine housing (highlighted red in the graphic). Each of these channels or “scrolls” is always fed by the exhaust pulses from the same two cylinders.

The layout and cross sections of the turbine impeller and compressor wheels have been correspondingly adapted and are designed for the maximum exhaust inlet operating temperature of 1020° C (1868° F).

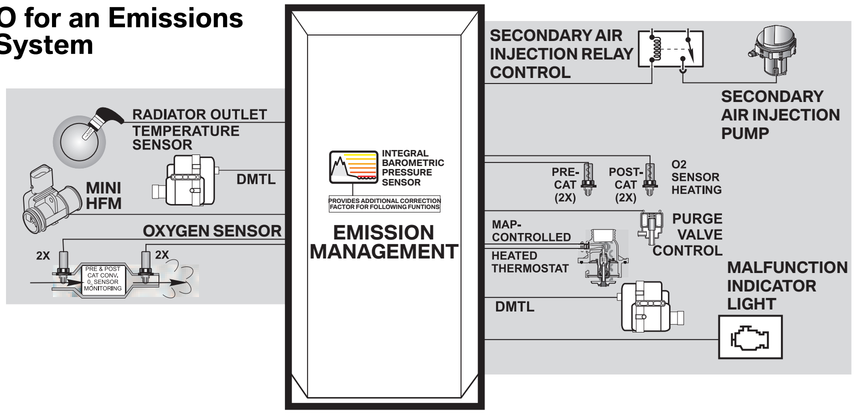
The specially designed exhaust manifold connects each of the 8 cylinders in sequence according to the exhaust pulses in the firing order. This delivers a uniform flow of exhaust gas to the turbochargers which improves volumetric efficiency by promoting cylinder scavenging.

Every 180° of crankshaft rotation, one exhaust gas pulse is fed to each turbocharger over the entire ignition sequence (1–5–4–8–6–3–7–2).

This highly efficient charging concept achieves optimum energy transmission of the exhaust flow to the turbine blades of the turbochargers. The result is the fastest and most direct response characteristics of any turbo engine worldwide. The innovative technology is patented by BMW and therefore represents a unique selling point over the competition.

Emissions Management Overview

Example of IPO for an Emissions Management System



One of the main purposes of the ECM is Emissions Management which includes the actuation of several components. In the following pages you will find a generic explanation on how this system works. For more detailed information please access BMW Training Reference Manuals found on-line.

The Emissions Management controls **evaporative** and **exhaust** emissions. The ECM monitors the fuel storage system for evaporative leakage and controls the purging of evaporative vapors. The ECM also monitors and controls the exhaust emissions by regulating the combustible mixture and after treating by injecting fresh air into the exhaust system. The catalytic converter further breaks down the remaining combustible exhaust gases and is monitored by the ECM for catalyst efficiency.

Oxygen Sensors

Oxygen sensor before catalytic converter

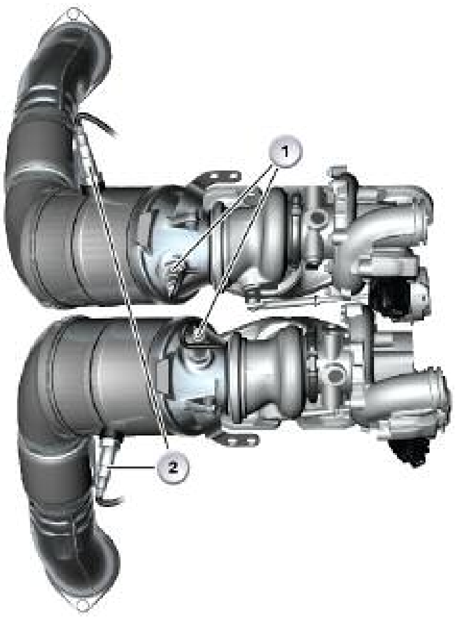
The pre-cat oxygen sensors measure the residual oxygen content of the exhaust gas. The sensors produces a low voltage proportional to the oxygen content that allows the ECM to monitor the air/fuel ratio.

The sensors are mounted in the hot exhaust stream directly in front of the catalytic converters.

Full operational readiness is achieved after 10 seconds (LSU 4.2 20 seconds).

Oxygen sensor after catalytic converter
The oxygen sensor after catalytic converter is also known as the monitoring sensor. Their purpose is to monitor the pre-cat sensor for proper operation.

The familiar Bosch monitoring and pre-cat sensors are used in most of our NG engines.



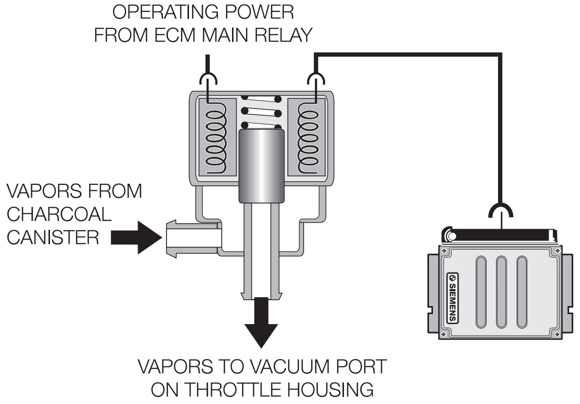
Index	Explanation
1	Pre-catalyst sensors
2	Post-catalyst sensors

Carbon Canister (AKF)

The AKF is used to prevent HC vapors from going to the atmosphere. As the hydrocarbon vapors enter the canister, they will be absorbed by the active carbon. The remaining air will be vented to the atmosphere through the end of the canister, DM TL and filter, allowing the fuel tank to “breath”.

When the engine is running, the canister is "purged" using intake manifold vacuum to draw air through the canister which extracts the HC vapors into the combustion chamber.

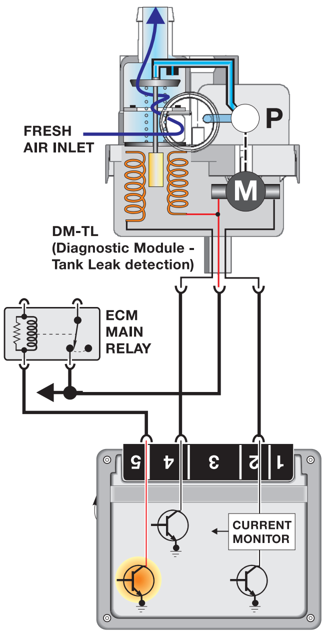
Evaporative Emission Valve



This ECM controlled solenoid valve regulates the purge flow from the Carbon Canister into the intake manifold. The ECM Relay provides operating voltage, and the ECM controls the valve by regulating the ground circuit. The valve is powered open and closed by an internal spring.

If the Evaporative Emission Valve Circuit is defective, a fault code will be set and the "Malfunction Indicator Light" will illuminate when the OBD II criteria is achieved.

Evaporative Leakage Detection (DM-TL)



This component ensures accurate fuel system leak detection for leaks as small as 0.5 mm by slightly pressurizing the fuel tank and evaporative components. The DM-TL pump contains an integral DC motor which is activated directly by the ECM. The ECM monitors the pump motor operating current as the measurement for detecting leaks.

The pump also contains an ECM controlled change over valve that is energized closed during a Leak Diagnosis test. The change over valve is open during all other periods of operation allowing the fuel system to "breath" through the inlet filter.

A heating element is integrated in the DM-TL pump to eliminate condensation. The heater is provided battery voltage with "KL15" and the ECM provides the ground path.

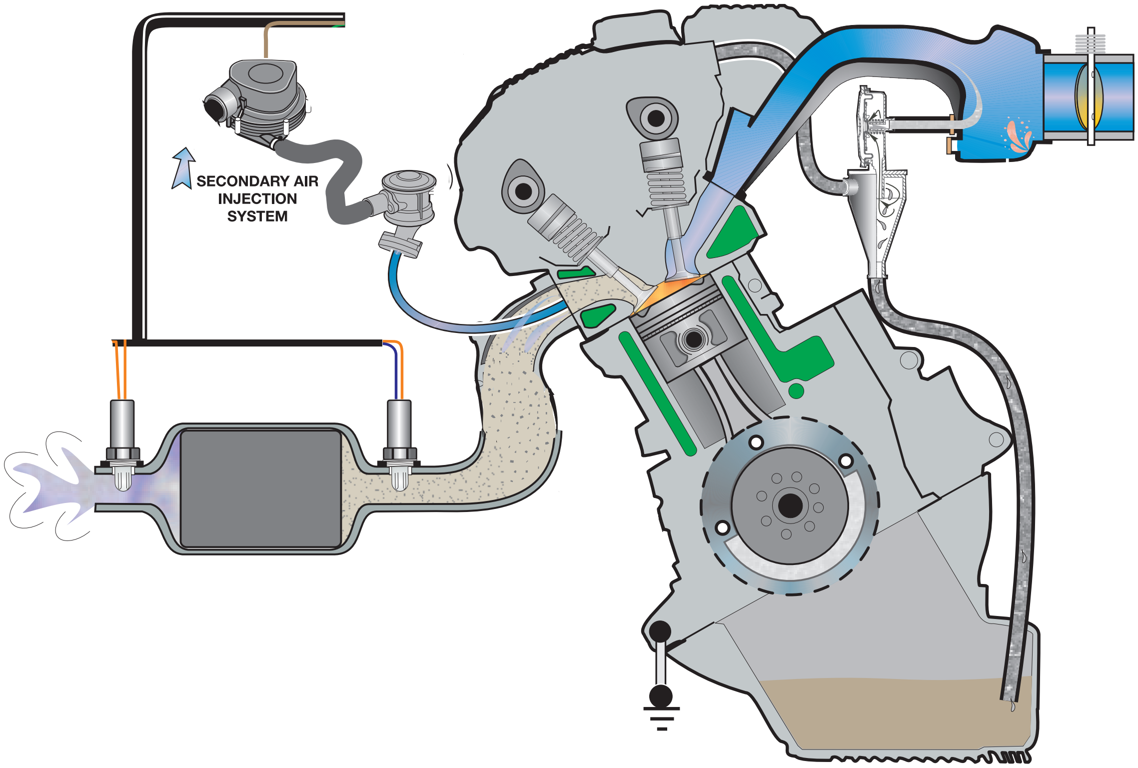
Exhaust Emissions

The combustion process of a gasoline powered engine produces Carbon Monoxide (CO), Carbon Dioxide (CO_2), Hydrocarbons (HC) and Oxides of Nitrogen (NOx).

- Carbon Monoxide is a product of incomplete combustion under conditions of air deficiency. CO emissions are dependent on the air/fuel ratio.
- Carbon Dioxide is a greenhouse gas that traps the earth's heat and contributes to Global Warming.
- Hydrocarbon are also a product of incomplete combustion which results in unburned fuel. HC emissions are dependent on air/fuel ratio and the ignition of the mixture.
- Oxides of Nitrogen are a product of peak combustion temperature (and temperature duration). NOx emissions are dependent on internal cylinder temperature affected by the air/fuel ratio and ignition of the mixture.

Control of exhaust emissions is accomplished by the engine and engine management design as well as after-treatment.

- The ECM manages exhaust emissions by controlling the air/fuel ratio and ignition.
- The ECM controlled Secondary Air Injection further dilutes exhaust emissions leaving the engine and reduce the catalyst warm up time.
- The Catalytic Converter further reduces exhaust emissions leaving the engine.



Electrically Heated Thermostat

Model specific variants of the electrically heated thermostat are equipped on all LEV/ULEV compliant engines. This thermostat allows the engine to run more efficiently than conventional thermostats improving fuel economy.

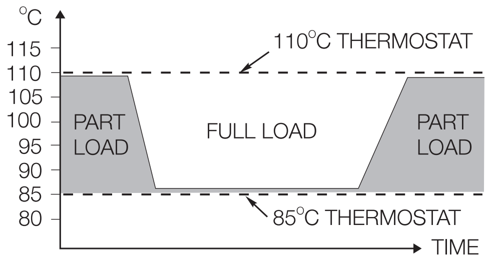
The ECM also electrically activates the thermostat to lower the engine coolant temperature based on monitored conditions. It is both a conventionally functioning and ECM controlled thermostat (two stage operation). The ECM control adds heat to the wax core causing the thermostat to open earlier than it's mechanical temperature rating providing increased coolant flow.

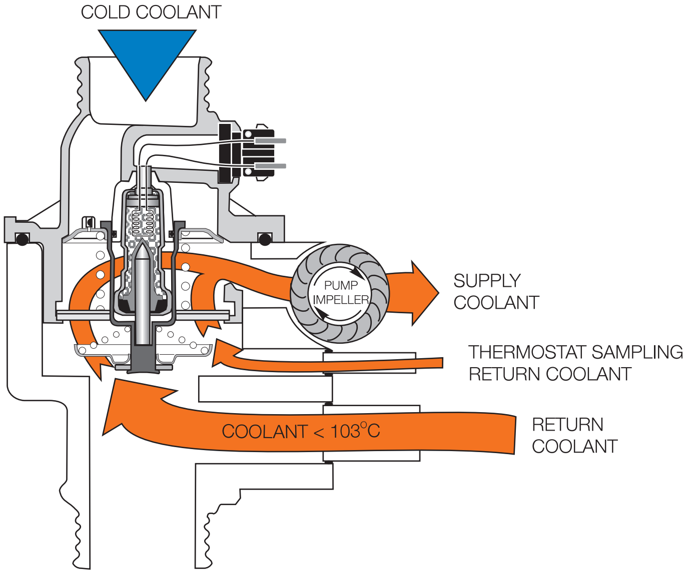
Conventional Function

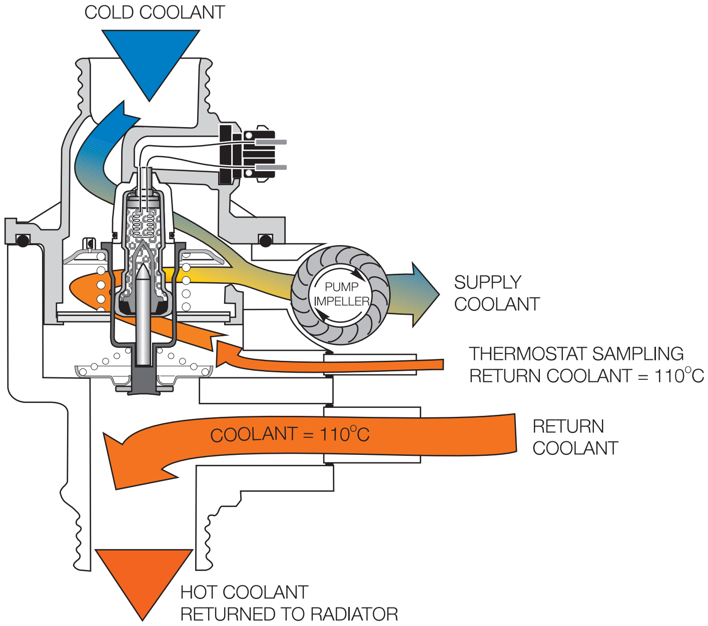
The thermostat begins to open at 103°C. This is at the inlet side of the water pump and represents the temperature of the coolant entering the engine. Before the 103°C temperature is realized, the coolant is circulated through the engine block by the water pump.

After the temperature reaches 103°C it is maintained as the inlet temperature by the thermostat. The coolant temperature at the water pump engine outlet is approximately 110°C. The additional 7°C are achieved after the coolant has circulated through the block.

The operating temperature of the engine will remain within this range as long as the engine is running at part load conditions and the engine coolant temperature does not exceed 113°C.





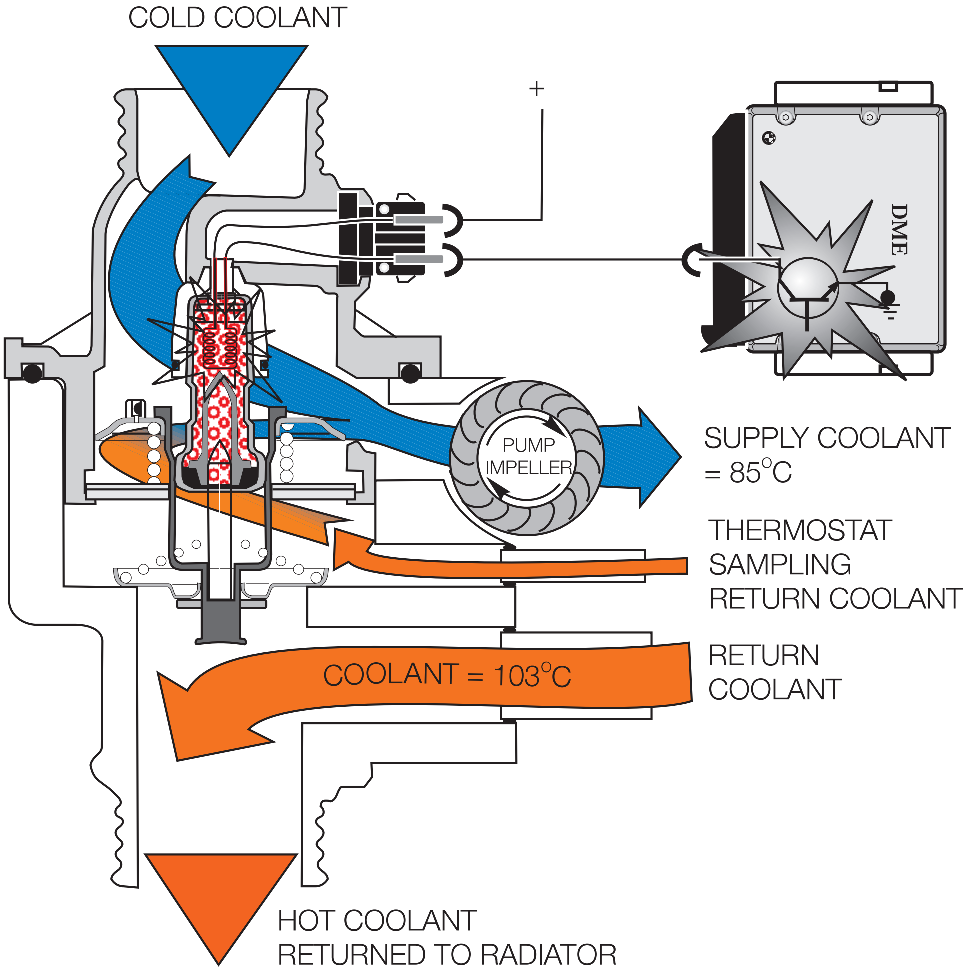


Electric thermostat activation is based on the following parameters:

- Engine temperature > 113°C
- Radiator Coolant Outlet Temperature
- Load signal “ti” > 5.8 ms
- Intake air temp > 52°C
- Vehicle speed > 110 MPH

When one or more of these monitored conditions is determined, the ECM activates (switched ground) the thermostat circuit. The activated heating element causes the wax core in the thermostat to heat up and open the thermostat increasing coolant circulation through the radiator which brings the engine temperature down.

The temperature of the coolant at the inlet side of the water pump will drop to approximately 85°C and the temperature at the outlet side will drop to approximately 103°C when activated.



Crankcase Ventilation

The crankcase ventilation system varies according to the engine.The pressure control valve and cyclonic oil separator are commonly used and combined into one unit.

Although the crankcase ventilation system and principle of operation remain the same, component location may change.

The pressure control valve varies the vacuum applied to the crankcase ventilation depending on engine load. The valve is balanced between spring pressure and the amount of manifold vacuum.

The oil vapors exit the separator labyrinth in the cylinder head cover. The oil vapors are drawn into the cyclone type liquid/vapor separator and regulated by the pressure control valve.

The oil vapors exit the pressure control valve into the intake manifold. The collected oil will drain back into the oil pan.

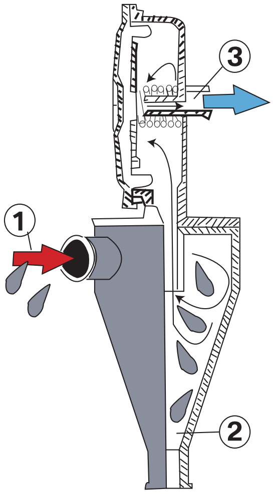
The vapors exit the pressure control valve and are drawn into the intake manifold through a centrally located port.

For turbocharged engines such as the N54, N55, N63 and N74, two non-return valves are used to prevent the risk of boost pressure being introduced into the crankcase.

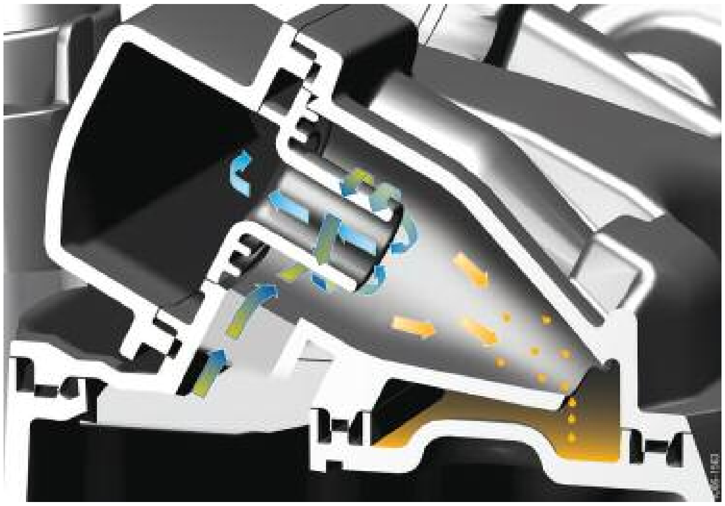
As the vapors exit the pressure control valve, they are drawn into the intake manifold.

At idle when the intake manifold vacuum is high, the vacuum reduces the valve opening allowing a small amount of crankcase vapors to be drawn into the intake manifold.

At part to full load conditions when intake manifold vacuum is lower, the spring opens the valve and additional crankcase vapors are drawn into the intake manifold.

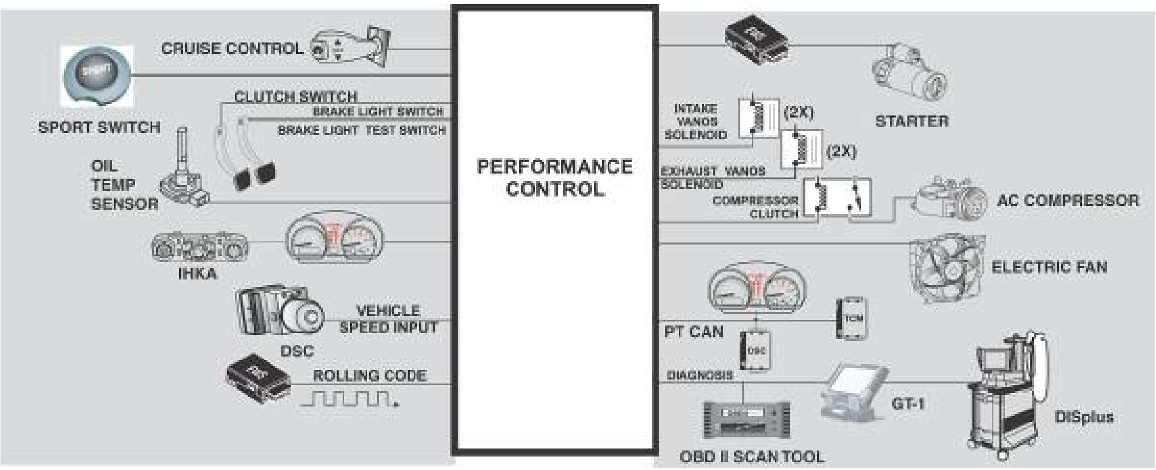


Index	Explanation
1	Engine Oil Vapors
2	Collective Drain Back Oil
3	Oil Vapors to the Intake Manifold



Performance Control Overview

Example of IPO for a Performance Control System



Dynamic Cruise Control

The cruise control with braking function was introduced with the BMW 3 Series (E9x). It is also referred to as "Dynamic Cruise Control" (DCC).

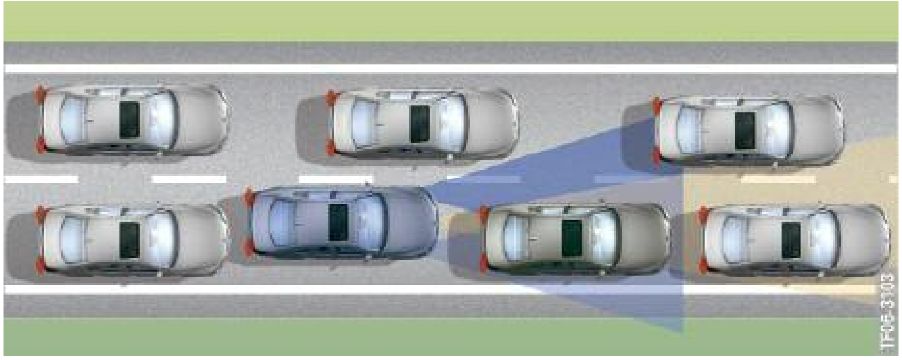
Mostly, DCC is a conventional cruise control system with some additional functions. The DCC offers the driver the opportunity to adjust the set speed in small or large increments, which is then set and maintained by the system by controlling power output and braking.

The brakes are also controlled during steep downhill driving if sufficient deceleration is not achieved by engine drag-torque alone.

Dynamic Cruise Control in vehicles with BN2020 is not computed in the DSC control unit as it is in other vehicles. Instead, it has been integrated into the ICM control unit.

Active Cruise Control with Stop & Go function

ACC Stop & Go is largely identical to that in the E6x LCI. ACC Stop & Go extends the operating range of the former ACC system to include low speeds down to a standstill.



In other words, speed and distance from the vehicle in front are automatically controlled at those speeds as well.

ACC Stop & Go will automatically stop the car if necessary and then indicate to the driver as soon as it detects that it is possible to start moving again.

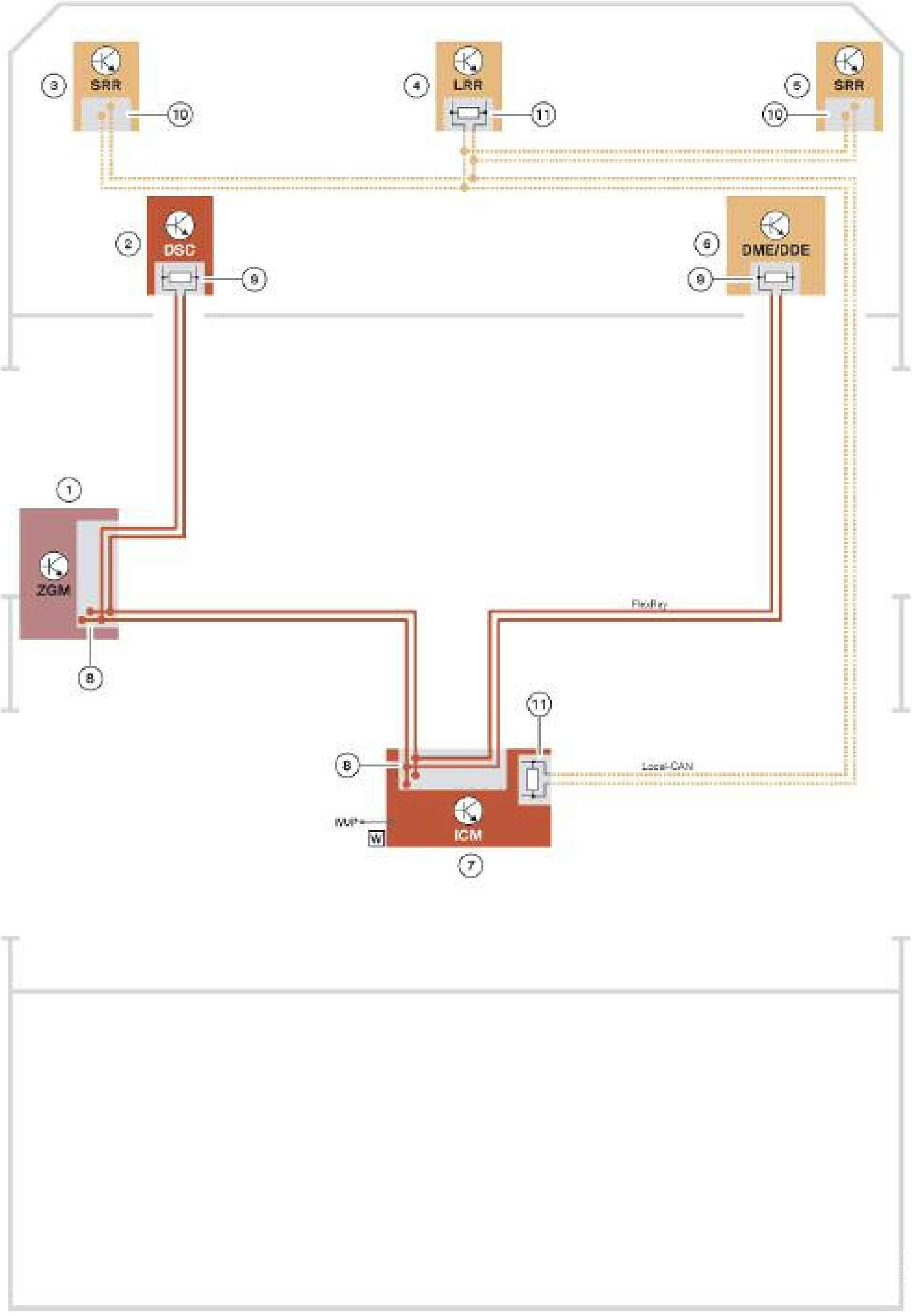
To pull away again, the driver has to acknowledge this message. The pulling-away process is controlled fully automatically by ACC Stop & Go only if the duration of the standstill is very short.

Thus, ACC Stop & Go provides optimum assistance for the driver not only in moving traffic but also in traffic jams such as are more and more frequently encountered on highways. However, this
system (in common with ACC) is not intended for use in urban areas for negotiating junctions or traffic lights.

The functions of ACC Stop & Go differ from those in the E6x LCI in the following areas:

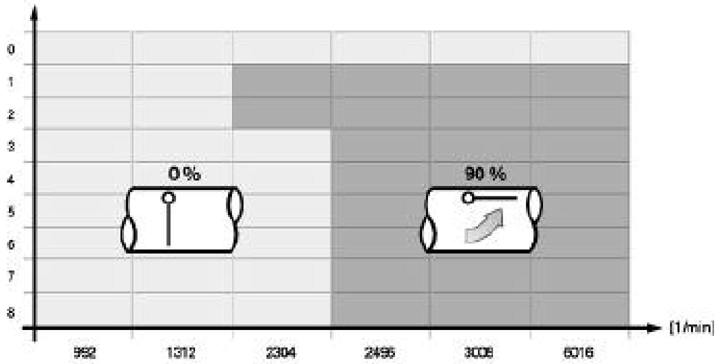
- Operation and display
- Behavior in response to driver's intention to get out.

F01 Bus Interface for ACC Stop & Go



Index	Explanation	Index	Explanation
1	ZGM	7	ICM
2	DSC	8	FlexRay bus
3	Short range radar sensor, left	9	FlexRay terminating resistor, DSC and DME
4	Long range radar sensor	10	Lo-CAN bus termination
5	Short range radar sensor, right	11	Lo-CAN terminating resistor
6	DME		

Exhaust Flap Control



The exhaust flap is designed to reduce noise at idle, low RPM acceleration and while coasting. The exhaust flap is controlled via vacuum actuator. The vacuum actuator is supplied vacuum via the engine driven vacuum pump.

The ECM controls the flap using a vacuum vent valve.

As compared to previous vehicles, the system no longer needs a vacuum reservoir. This is due to the fact that the vacuum is not supplied by the engine and not subject to variations in intake manifold vacuum.

The exhaust flap is sprung open and closed by vacuum. The ECM will de-activate the vacuum vent valve in order to open the flap.

The flap is opened above approximately 2500 RPM. Flap operation is also dependent upon engine load.

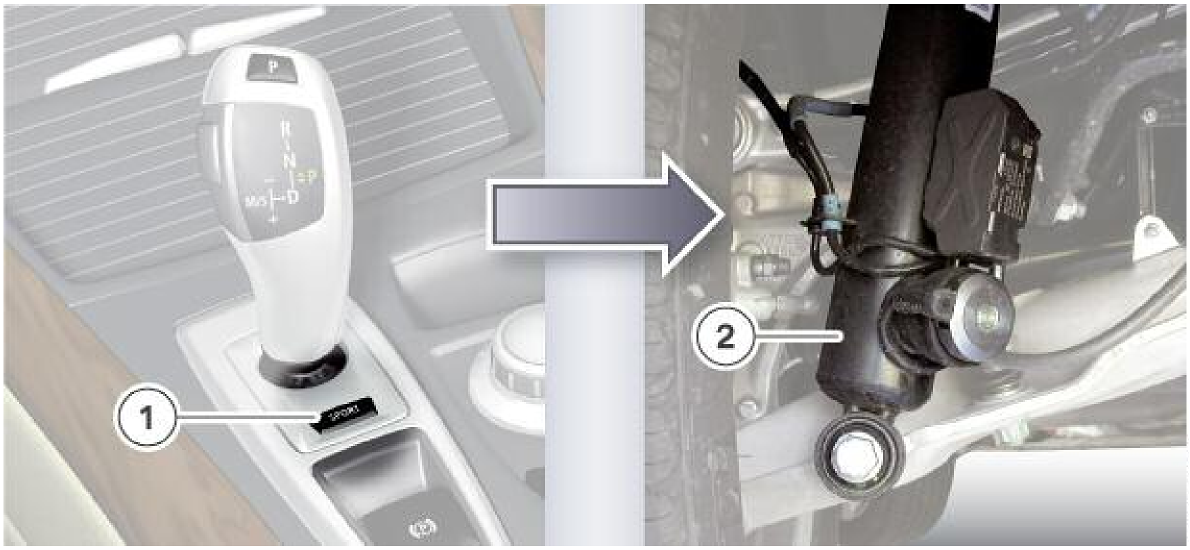
Dynamic Driving Control - “Sport Switch”

A central, higher-level of Driving Dynamics Control system was first introduced in BMW vehicles several years ago. Control elements are already installed in a number of BMW models that the driver can use to switch individual systems to a sporting mode. This includes the sports setting of the automatic selector lever where only the shift characteristics of the automatic gearbox are influenced.

The system behaves in a similar manner when the SPORT button for the Electronic Damping Control or Vertical Dynamics Control (shown right) is used. This only changes the characteristic (hardness) of the shock absorber.

The first time a SPORT button influenced several systems was in the E85/E86. The corresponding “Driving Dynamics Control” function effects a changeover between a standard mode and a sporting mode in the steering, automatic gearbox and accelerator pedal. This meant it was now possible to coordinate these three systems far more effectively in both modes with the result that the customer now experiences a car that is uncompromisingly tailored to “Sport” in every sense.

SPORT Button in E70/E71



Index	Explanation	Index	Explanation
1	SPORT button	2	Vertical Dynamics Control with electronically adjustable shock absorbers

The Driving Dynamics Control has been further improved in vehicles with BN2020 (e.g. F01/F02) as it now contains two groundbreaking features when compared to the E85/E86:

1. All drive and dynamic driving systems installed in the vehicle are comprehensively switched over.
2. Four settings are available. The status of the Dynamic Stability Control is also taken into account thus ensuring that two additional settings are possible.

The changeover operations for many drive and driving dynamics functions are therefore bundled in the driving dynamics control The vehicle as a whole then behaves as the driver would expect in accordance with his/her chosen setting. This bundling can make the handling characteristics of the vehicle considerably more distinctive and less compromising.

When sport mode is activated, the driving dynamics of the vehicle take on sportier qualities. The Sport mode (“Sport +” is available in certain models) can be operated via a driving dynamics switch located in the center console. The electronic control units switch to more dynamic settings, making the engine more responsive (EDK) with a firmer steering strategy (EPS), less body roll (ARS) and a sportier suspension setting (VDM - EDC).

Additionally in vehicles equipped with automatic transmission (EGS), BMW's Double Clutch Transmission (DCT) or Sequential Manual Gearbox (SMG), activating the sport mode shortens gearshift times and makes the gearshift characteristic even more dynamic.

In certain vehicles the Dynamic Driving Control allows the driver to customize the system it wants to influence: **Drive Train, Chassis, and/or Transmission** (in addition the driver can use the controller to make further settings).

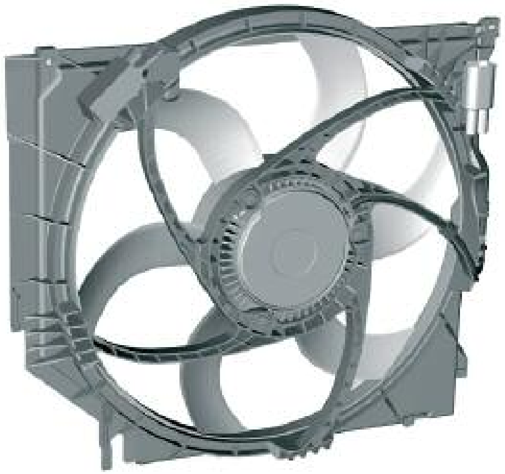
The Dynamic Driving Control function request is carried over by the DME/ICM (depending on the vehicle) through the bus network to the following control modules:

- ICM - Integral Chassis Management.
- DME - The engine control system for the accelerator pedal characteristic.
- EGS/DCT/SMG - The electronic gearbox control for driving programs and shift speed.
- EPS - Power Steering assistance (Servotronic).
- KOMBI/CID - Display relevant DDC information to the driver.
- ARS - Active Roll Stabilization varies the stiffness/response characteristic of the sway bars.
- VDM - The Vertical Dynamics Management varies the stiffness/response characteristic of the dampers.
- DSC - DTC is activated in "Sport +".

DTC button and Driving Dynamics switch

Index	Explanation
1	DTC button
2	Driving Dynamics Switch

Electric Fan



As usual, the electric fan has its own electronics module and is controlled dependent on engine speed and temperature by a pulse-width modulated signal. The pulse duty factor during normal operation (100 Hz) is converted into a speed signal.

- 7% pulse duty factor wakes the fan electronics
- 11% pulse duty factor equates to 33% of the maximum fan speed
- 93% pulse duty factor equates to the maximum fan speed
- 97% pulse duty factor is a command for self-diagnosis of the fan electronics

To output the fan after-running command, the output frequency of the DME is reduced to 10 Hz during the latching phase (terminal KL_15 OFF). The fan time and speed are selected based on the pulse duty factor.

A further new feature is that the DME switches the power supply through terminal 30 via a relay.

The electric cooling fan is controlled by the ECM for engine cooling system and air conditioning system requirements. The ECM uses a remote power output final stage (mounted on the fan housing). The electric fan is controlled by a pulse width modulated signal from the ECM.

The fan (and speed) is activated by the ECM based on:

- Coolant outlet temperature
- Catalyst temperature
  (calculated by the ECM)
- Vehicle speed
- Battery voltage
- Air Conditioning refrigerant pressure
  (calculated by IHKA and sent via the PT CAN bus to the ECM)

ECM Integrated Temperature Sensor

The E Box fan is controlled by the ECM. The control module contains an integral NTC temperature sensor for the purpose of monitoring the E box temperature and activating the fan.

When the internal temperature exceeds 65° C, the ECM provides a switched ground for the E Box fan to cool the E box control modules.

Alternator Interface

The alternator communicates data with the ECM via the BSD line (bit-serial data interface - single wire). This is necessary to allow the ECM to adapt its calculations and specific control data to the alternator output. In addition, the ECM controls the following functions:

- Activation/deactivation of the alternator.
- Informing the voltage regulator of the nominal voltage value to be set.
- Controlling the alternator's load response.
- Diagnosing the BSD line.
- Storing alternator fault codes.
- Activating the charging indicator light in the instrument cluster.

The charging indicator light operation has not changed from present vehicles.

PT-CAN Bus Communication

The ECM provides signals to other "driveline" related modules for torque control, shift quality, diagnosis, safety enhancements, etc.